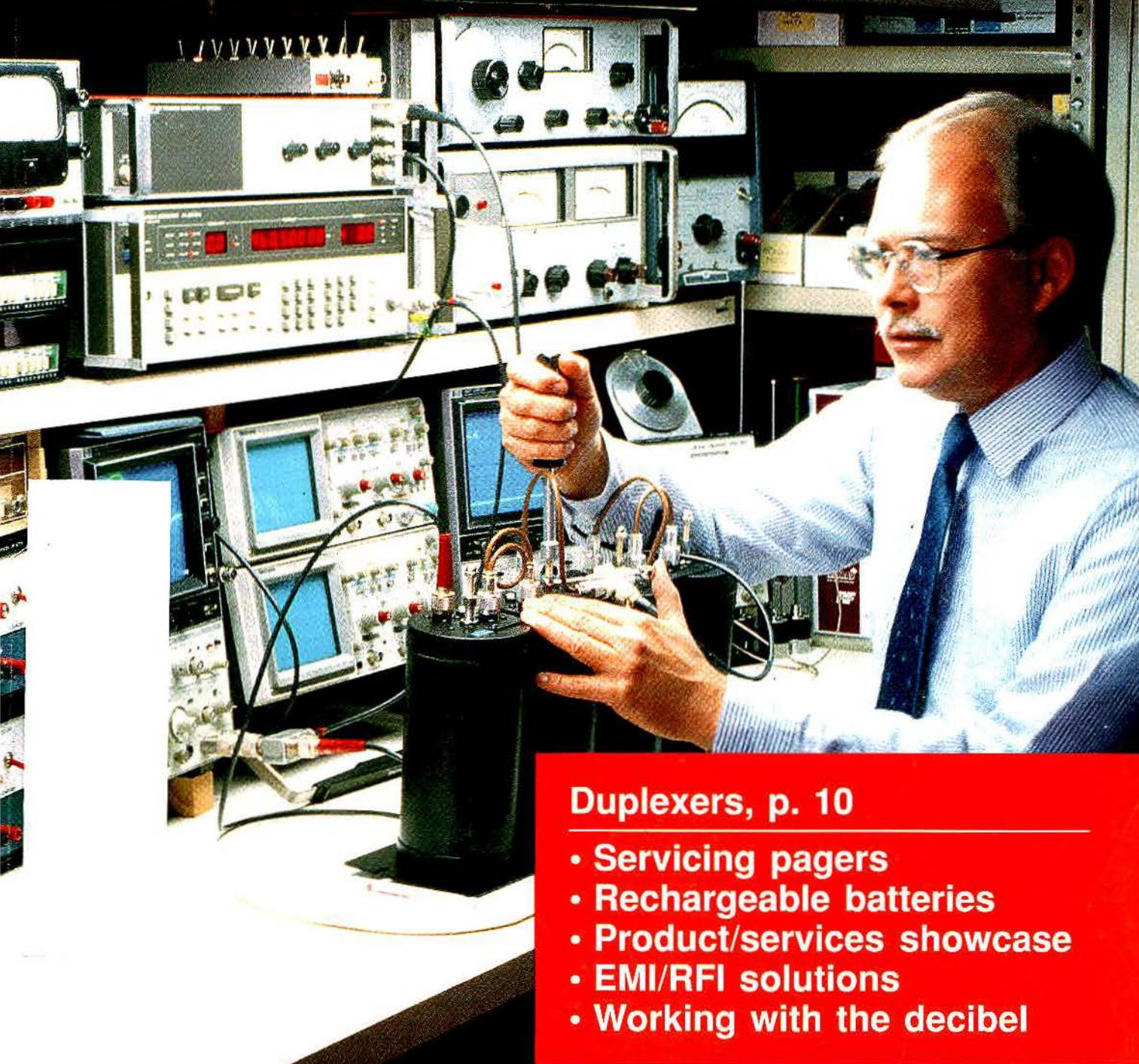


July 1994/\$3

Mobile Radio Technology

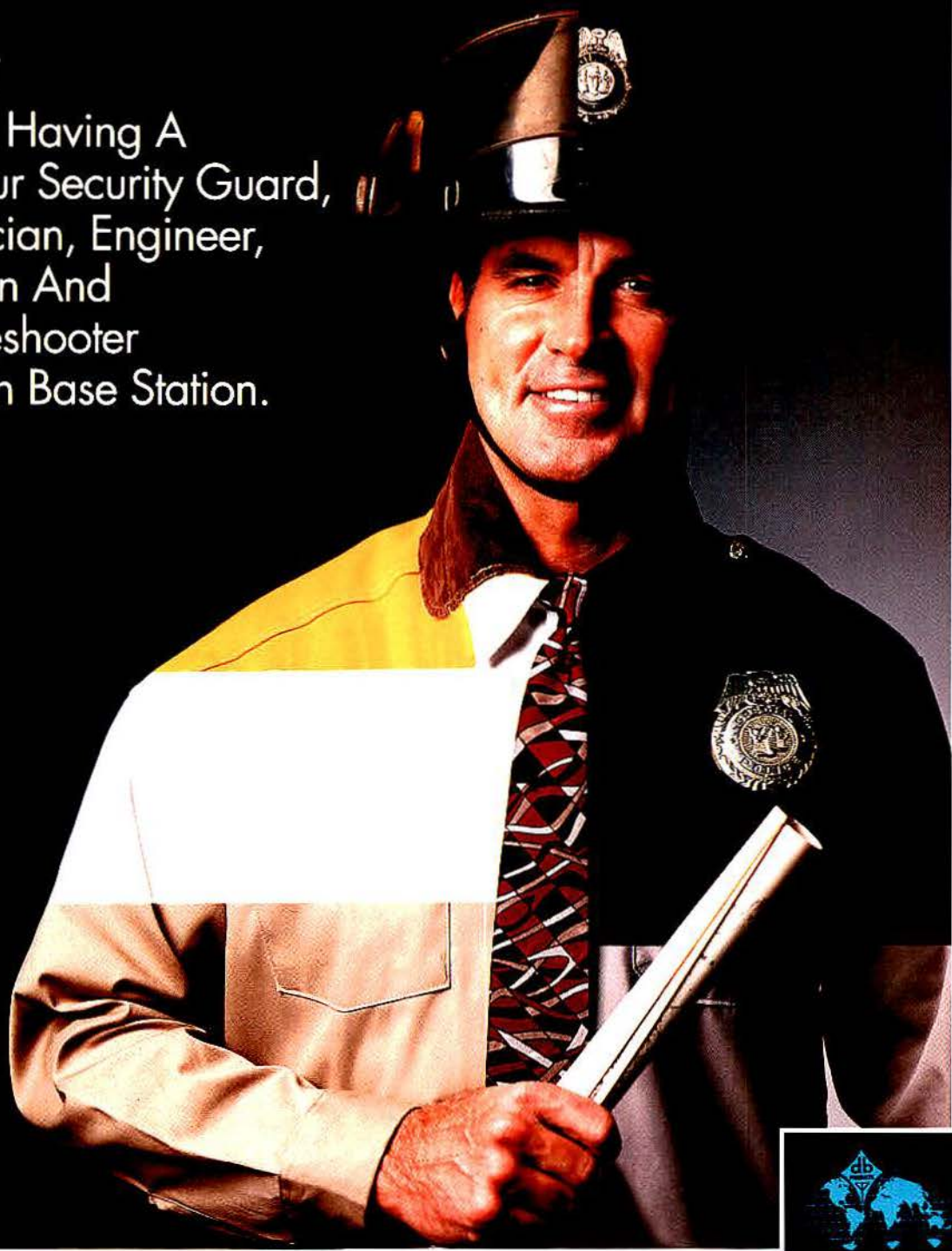
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Duplexers, p. 10

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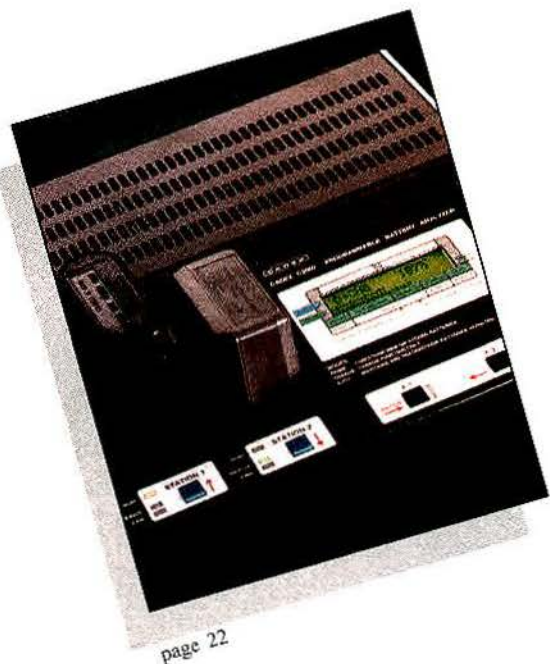
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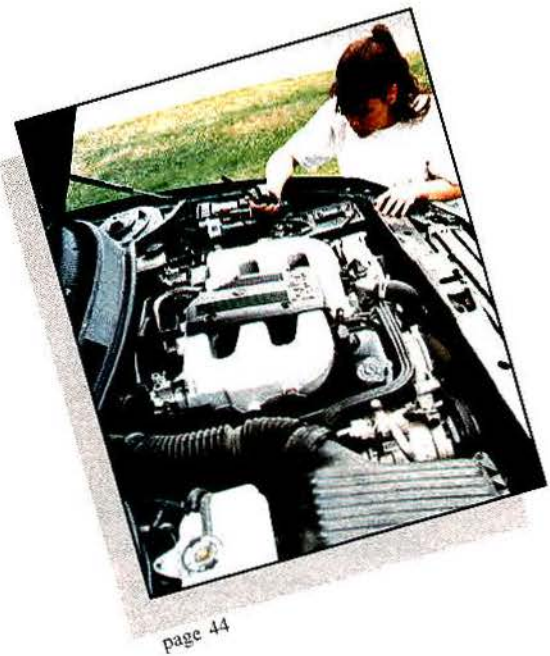
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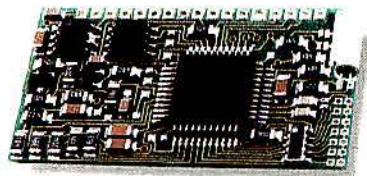


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On the cover: Robert Wiles tunes a duplexer for the Antenna Farm, Overland Park, KS, prior to shipment to a customer. See related article on page 10.

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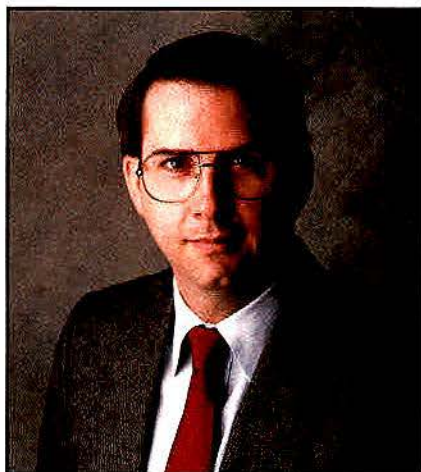
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Scanning . . .



Forest Service fees

Congress may rein in the U.S. Department of Agriculture's efforts to raise fees for electronic communications site permits on lands managed by divisions of the department, the U.S. Forest Service and the Bureau of Land Management.

Actually, in proposing much higher fees in the first place, the Forest Service was carrying out what it thought was Congress' bidding under the Federal Land Policy Management Act. The act called for fees to be raised to fair market value. The Forest Service conducted a survey that many electronic site permit holders thought was improperly done or interpreted, resulting in proposed fees that they thought were much higher than fair market value.

With land mobile radio licensees and broadcasters on the same side of the issue, Congress responded by limiting increases to 10% in the 1993 Omnibus Budget Reconciliation Act. Now, Congress is poised to consider Senate Bill 2106, "The Equitable Communications Site Fee Act of 1994," which would modify the fee structure to a level that seems to be more fair and reasonable, according to many permit holders.

Private system capacity

The New York City police department is reported to be finding portable cellular phones useful in communicating within crowds during civil unrest and for calling precinct stations for non-emergency assignments having to do with non-injury crimes. Some divisional radio communications systems apparently can be overloaded when thousands of officers respond to an area during a disturbance. Officers in

the non-injury crime program apparently are asked not to use the department's radio communications system to call for assignments but instead to come to the station or to telephone—thus, the popularity of the cellphones.

It is good that cellphones can supplement private radio communications systems used by public safety agencies. Even so, would a cost analysis show that money spent increasing the private system capacity would be less than what is spent on cellular telephone airtime charges? Expediency can be expensive, but at least the cellphone method works, and it is quick to implement.

High-stakes construction deadlines

The court-appointed receiver has weighed in with a material request in the Federal Trade Commission's action against so-called specialized mobile radio (SMR) application mills. The receiver has asked the FCC to extend the construction periods associated with licenses obtained through applications the mills prepared. Many of the licenses are controlled by the application mills under management agreements with the license lottery winners.

This request is a high-stakes matter because several consolidated SMR operating companies have contracted to buy blocks of channels from the receiver. Unless constructed within the period allowed, the channels revert to the FCC for reassignment.

Smaller SMR operators may lose an opportunity to add channels to their systems if the construction periods for the licenses in question are extended, and investors who believed the application mills' inflated promises could lose a bigger part of their investment if they are not.

We think the FCC should not extend the construction periods, and that it ought to take steps to prevent further abuses by application mills.

Local radio regulation

State and local governments are flexing their muscles more and more when it comes to regulating radio communications. You might think such regulation is under the exclusive jurisdiction of the federal government, but state and local governments have extended their authority to radio communications in limiting antenna construction and radio receiver use. The next step appears to be state and local regulation of "RF radiation," potentially meaning all radio transmitters.

For example, Massachusetts enforces its

own RF radiation regulations, and New Jersey has proposed regulations and fees that could contradict federal guidelines.

As difficult as federal regulation can be, it is better to have only one set of federal regulations to deal with than as many as 50 sets of state regulations and who knows how many sets of city regulations. The federal government ought to find a way to reassert what once was thought to be its exclusive jurisdiction over matters having to do with radio transmission and reception.

Along the way, we would like to see some relief from state and local regulation of amateur radio antennas, too.

Stuart Meyer

As it was time to complete this column, we learned of the passing of Stuart F. Meyer, a figure in the radio communications industry for nearly 50 years. Meyer, who was a founding member of our editorial advisory board, passed away May 21 at his home in Vienna, VA.

He pursued a vigorous schedule. Meyer had just returned home from an Association of Public-Safety Communications Officials International meeting in Milwaukee. He was chairman of the association's Project 25 Interface Committee, in which capacity he oversaw the work of all of the project's task force groups. He also was the federal government liaison for Ericsson GE Mobile Communications, Lynchburg, VA, handling FCC matters for the company as he did in previous years for the Radio Corporation of America and E.F. Johnson Company.

Meyer was assistant chief engineer at Link Radio from 1945 to 1953, chief engineer of the mobile radio division of the DuMont company from 1954 to 1960, president of Hammarlund and an executive at Aerotron in the '60s and '70s.

Meyer served four years as president of the Quarter Century Wireless Association, and last year he was president of the Radio Club of America, after serving that organization for many years as executive vice president. His efforts in both the commercial and non-commercial facets of the radio communications industry and hobby were extensive.

We had the pleasure of working more closely with Meyer during the past couple of years than ever before because of our involvement with Radio Club publications.

He was always willing to lend us a helping hand both on a personal basis and through our commercial and volunteer projects. We'll miss you, Stu.

—Don Bishop

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17-20—**Forestry-Conservation Communications Association**, Hershey, PA. Contact: Don Pfohl, 602-644-3166.

August

6-11—**International Municipal Signal Association**, Cavanaugh's Inn, Spokane, WA. Contact: Harold Glerum, 800-723-4672.

7-12—**Association of Public-Safety Communications Officials—International National Conference**, Lawrence Convention Center, Pittsburgh. Contact: 800-949-2726.

September

22-24—**Personal Communications Showcase**, Washington State Convention Center, Seattle. Contact: 800-326-8638.

27-Oct. 1—**International Conference on Universal Personal Communications**, sponsored by the Institute of Electrical and Electronics Engineers, Hyatt Regency San Diego, San Diego. Contact: Nokia Mobile Phones, 800-306-6542.

October

3-5—**WirelessWorld Conference & Exhibition**, sponsored by *Cellular Business* magazine, The Stouffer Orlando Resort, Orlando, FL. Contact: Chris Lotesto, 800-458-0479.

19-21—**International Wireless Communications Expo/Fall**, Tampa Convention Center, Tampa, FL. Contact: 800-828-0420.

November

3-5—**Industrial Telecommunications Association and Council of Independent Communication Suppliers Annual Meetings**, The Kingsmill Resort and Conference Center, Williamsburg, VA. Contact: Barbara J. Levermann, 703-528-5115.

9-13—**CMA '94**, sponsored by the Communications Marketing Association, Radisson Plaza Lord Baltimore Hotel, Baltimore, MD. Contact: Jack Armstrong, 410-628-9300.

18—**Radio Club of America**, Communications Symposium, 85th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

December

6-8—**Wireless Datacomm Fall**, Washington Convention Center, Washington, DC. Contact: 800-322-9332.

1995

February

1-3—**Cellular Telecommunications Industry Association Winter Meeting and Exposition**, New Orleans. Contact: 202-785-0081.

March

TBA—**Government Land Mobile Communications conference**, sponsored by TMSA Conferences, Washington, DC. Contact: Steven Silver, 310-534-4871.

13-14—**AMTEX**, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, The Buttes, Tempe, AZ. Contact: 202-331-7773.

20-23—**Supercomm**, sponsored by USTA and TIA, Anaheim Convention Center, Anaheim, CA. Contact: 202-326-7300.

April

3-5—**Energy Telecommunications and Electrical Association**, George R. Brown Convention Center, Houston. Contact: 214-235-0655.

25-27—**International Wireless Communications Expo/Spring**, Las Vegas Sands Convention Center, Las Vegas. Contact: 800-828-0420.

May

30-June 2—**Radiocomm**, Toronto Metropolitan Convention Center, Toronto. Contact: 613-233-4888.

July

26-28—**Vehicular Technology Conference**, sponsored by IEEE Vehicular Technology Society, Hyatt Regency Chicago O'Hare, Chicago. Contact: Keith Paglusch, chairman, 312-399-2378.



Mobile Radio Technology

The journal of mobile communications technology

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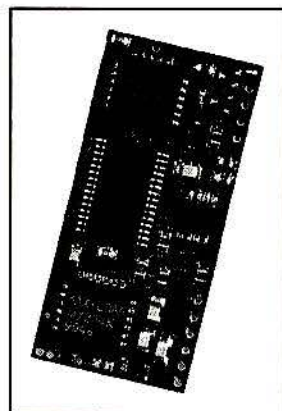
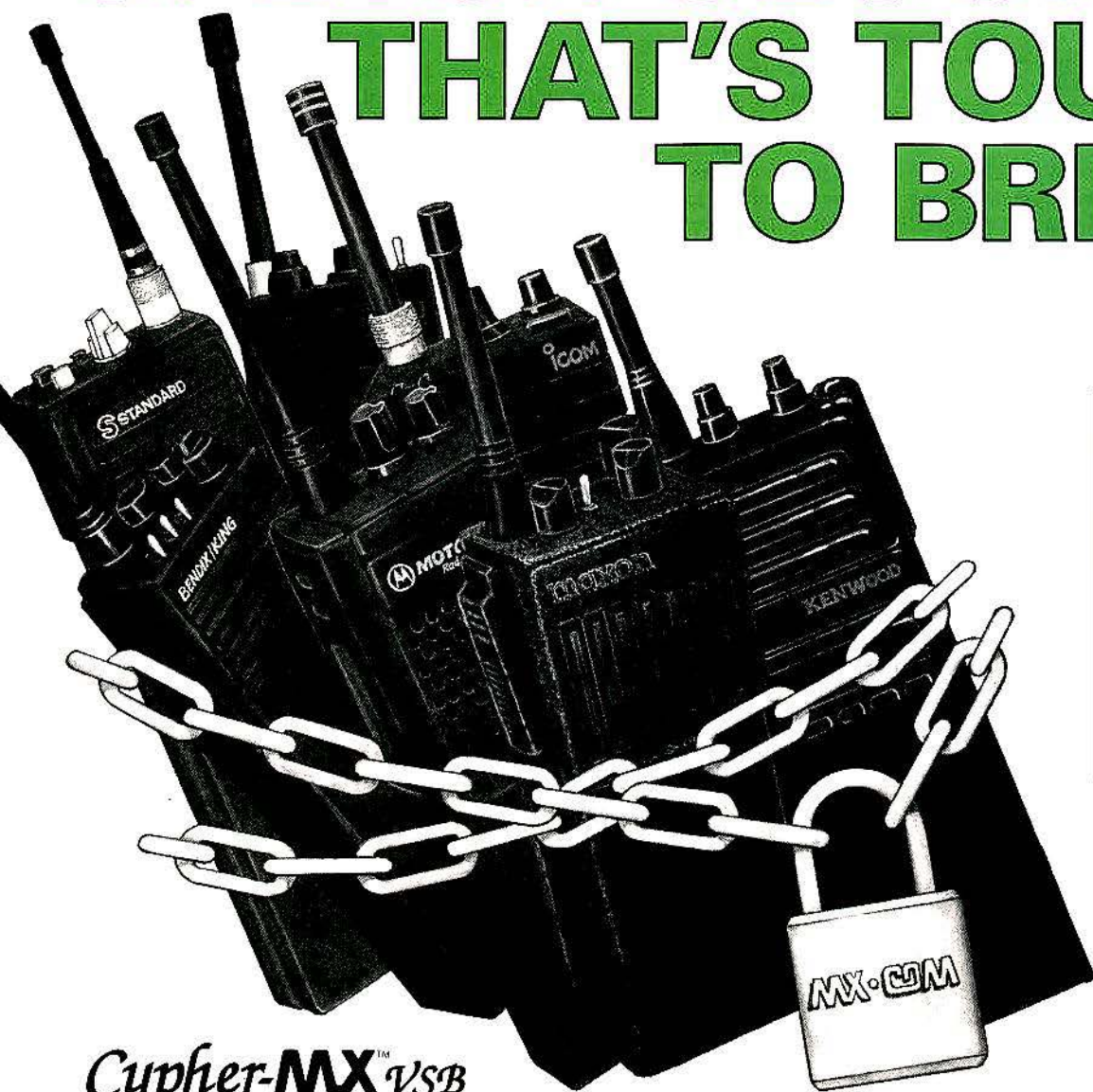
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Working with the decibel

By Harold Kinley, C.E.T.

The decibel (abbreviated dB) is such an important unit of measurement in the communications world that an occasional review of its use never hurts. Let's take a look at how the decibel was developed and some ways it is used.

The ear responds to changes in sound intensity in an approximately logarithmic manner. The basic unit of comparison of two power levels is the *bel*—named after Alexander Graham Bell. Formula 1 to the right is the mathematical expression for the bel. All other formulas for decibels are derived from this formula.

One bel represents a power ratio of 10:1. For example, if the input to an amplifier is 1W and the output is 10W, the amplifier gain is 1 bel. In practice, the bel was found to be too large a unit of comparison. For example, a power ratio of 2 equals 0.3 bels. Thus, any power ratio less than 10 is a fractional part of a bel (less than 1 bel). Rather than express so many power ratios in decimal or fractional parts of a bel, the *decibel* was adopted.

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

Because the decibel is one-tenth of a bel, an amplifier with 1 bel of gain has a 10 decibels of gain, or 10dB. Formula 2 is the basic formula for calculating decibel gain (or loss) from a power ratio. If P_o (power output) is less than P_i (power input), the decibel figure is negative, indicating a loss. As long as P_o is greater than P_i , the decibel figure is positive.

Power Ratios

$$(1) B = \log \left(\frac{P_o}{P_i} \right)$$

$$(2) dB = 10 \log \left(\frac{P_o}{P_i} \right)$$

$$(3) dB = 10 \log \left(\frac{E_o^2}{E_i^2} \right)$$

$$(4) dB = 20 \log \left(\frac{E_o}{E_i} \right)$$

$$(5) dB = 20 \log \left(\frac{E_o \sqrt{R_i}}{E_i \sqrt{R_o}} \right)$$

$$(6) dB = 10 \log \left(\frac{I_o^2}{I_i^2} \right)$$

$$(7) dB = 20 \log \left(\frac{I_o}{I_i} \right)$$

$$(8) dB = 20 \log \left(\frac{I_o \sqrt{R_o}}{I_i \sqrt{R_i}} \right)$$

It is important to remember that the decibel is a comparison of *power* levels, or a power ratio. Because power is a function of voltage or current, the decibel also can be calculated from voltage or current as long as circuit resistance, or impedance, is taken into account. If voltage or current is compared in the *same* impedance, then the impedance can be neglected. The impedance does not enter into the decibel calculations for power because power itself takes impedance into account.

Because power is proportional to the *square* of the voltage, Formula 3 can be applied as long as the voltages are across equal impedances. Formula 4 is a simplified form of Formula 3. If the output voltage (E_o) and the input voltage (E_i) are across different impedances (R), then Formula 5 must be applied to take the different impedances into account.

Because power also is proportional to the square of the current, Formula 6 can be used to calculate decibels from current levels in the same impedance. Formula 7 is a simplified form of Formula 6. If I_o and I_i are across different impedances, then Formula 8 must be applied.

One basic rule always must be observed when using these formulas (and any other formulas involving measuring units): Be sure that the power (P_o and P_i), voltage (E_o and E_i), current (I_o and I_i) or resistance (R_o and R_i) are in the same units of measure. For example, do not enter P_o in watts and P_i in milliwatts.

Equal input/output impedance

Refer to Figure 1 below. Resistors R_o and R_i represent the output and input impedances, respectively, of the amplifier. What is the amplifier gain in decibels? Because so much information is given, there are several ways to solve this question for decibels. We first could find the input and output power

(continued on page 30)

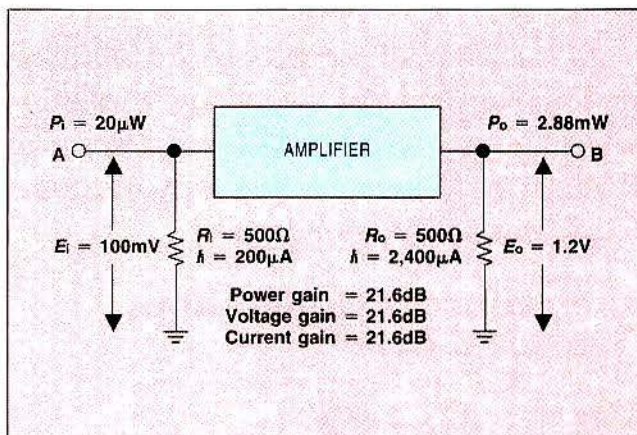


Figure 1. Resistor R_i represents the amplifier input impedance; resistor R_o , output impedance

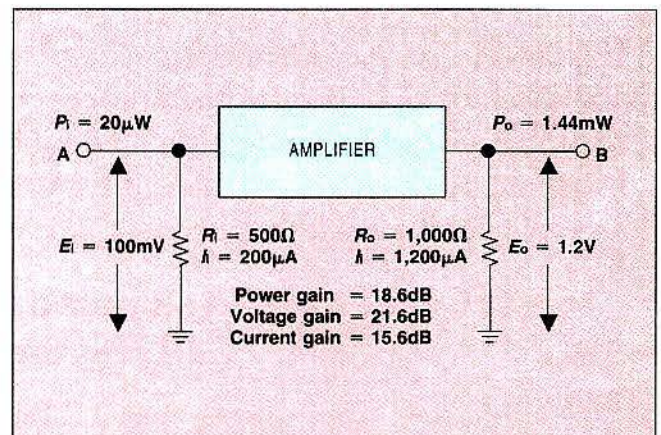


Figure 2. This figure differs from Figure 1 in that the input and output impedances of this amplifier are different.

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How to use duplexers: Isolation requirements

Part 1—Duplexers in various forms isolate simultaneously operated transmitters and receivers. Here are some steps to follow to calculate the required isolation. Impedance differences make duplexers work.

By Brian J. Henderson, P.E.

You have just installed a base station and mobile radio system, perhaps for a customer.

Coverage is satisfactory from the base station to the mobile radios. Mobile-to-mobile range is limited. The customer wants to consider a repeater system to improve mobile range.

You want to serve the customer the best way you can. You buy a repeater. You install an antenna. You know you must buy a duplexer. Why? What does a duplexer do?

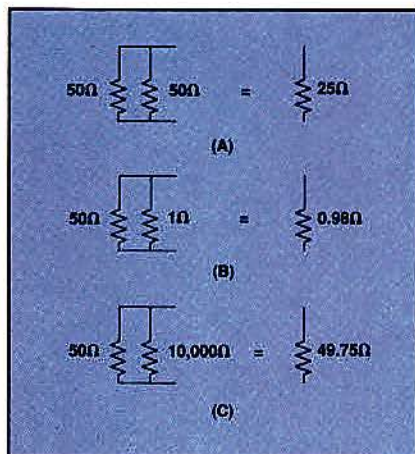


Figure 1. A duplexer uses impedance differences to isolate the transmitter and receiver. At (A), two 50Ω resistors or 50Ω coaxial cables wired in parallel have a resulting impedance of 25Ω. When connected to another 50Ω device, the connection represents an impedance mismatch and results in a power loss. At (B), when a 50Ω impedance circuit is connected in parallel with a 1Ω impedance circuit, the combined impedance is extremely close to 1Ω, almost a short circuit. At (C), when a 50Ω impedance circuit is connected in parallel with a 10,000Ω impedance circuit, the combined impedance is extremely close to 50Ω, meaning that there is little effect upon the 50Ω circuit's impedance.

A duplexer allows the use of a single antenna for transmitting and receiving simultaneously, as a repeater usually does.

Duplexers come in many shapes, sizes and types from many manufacturers. They often are described in antenna catalogs. Duplexers also may be called filters, combiners and cavities. Many people consider them to be mystical things that only engineers know about.

Duplexers, including filters, reject, pass and other "cavity devices," actually are quite straightforward once you understand the basics. The following describes the basics of filters, reject, pass and other "cavity filter devices."

Why is a duplexer required?

There are three reasons why a duplexer is used.

The first is to provide isolation between the transmitter and receiver.

The second is to preserve impedance matches among the antenna, transmitter and receiver. Impedance must be maintained at 50Ω to keep everything operating at maximum efficiency.

The third is to prevent several transmitters and receivers from interfering with each other and causing or receiving intermodulation products and other interference.

Isolation

In a mobile or base station radio, the transmitter and receiver do not operate at the same time.

When the receiver is on, and the channel is being monitored, the transmitter is turned off. When the operator presses the push-to-talk (PTT) button and transmits, the receiver is turned off.

A repeater receives a signal in the receiver and rebroadcasts the audio through the transmitter at the same time. This type of operation is called full-duplex because

the transmitter and receiver are both on and operating at the same time. Full-duplex operation gives its name to the "duplexer."

Note that the receiver is receiving a signal of only a few microvolts (extremely small). The transmitter is transmitting a signal of several volts (extremely large). What is required is a device to separate or to isolate the receiver from the transmitter so that the two can operate at the same time without interfering with each other.

The receiver must continue to receive extremely small signals while the transmitter transmits extremely large signals. That is where the duplexer comes in. It will provide the required isolation between transmit and receive frequencies.

As an example of isolation, consider a 25W repeater package. The transmitter operates at a power level of 25W or +44.0dBm. The receiver is rated at 0.5μV or -113.0dBm. The difference between these two signal levels is 157dB.

The repeater must operate at both of these power levels. Using two different frequencies provides a certain amount of isolation. A duplexer provides additional isolation so that the repeater can operate in full-duplex mode.

A duplexer prevents receiver desensitization (desense) from occurring. That means that the receiver is as sensitive when the transmitter is on as when the transmitter is off.

How much isolation?

How much isolation is necessary depends on two factors: the amount of frequency separation between transmitter and receiver, and the transmitter output power.

Frequency separation is the main

Henderson is senior engineer, communications, with Canadian Western Natural Gas, Calgary, Alberta.

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governing factor. Manufacturers graph *duplex curves* for each radio they produce. These curves tell you how much transmitter noise is produced by a transmitter at a given receiver separation from the transmit frequency. Sometimes these curves are available from the manufacturer; sometimes they are not.

The manufacturer always specifies *adjacent channel selectivity*. This specification can be used as a guideline. Adjacent channel selectivity is usually specified for either 25kHz or 30kHz channel spacing, and that is the spec that can be used.

Transmit power is the other factor. The more transmit power, the more isolation required. All calculations should be based on maximum transmit output power. Otherwise, turning the power up on the transmitter causes receiver desense, and the repeater will not operate properly.

As an example, take the same 25W transmitter as before.

25W = +44.0dBm

0.5μV = -(-113.0dBm)

Receiver selectivity = -85dB

Minimum required isolation = 72.0dB

3dB safety factor = 3.0dB

Total isolation required = 75.0dB

As a rule of thumb, when using this method, make sure that you have at least 3dB additional isolation to allow for any increase in transmitter power or decrease of receiver rejection in the future. In this case, isolation should be 72.0dB + 3.0dB = 75dB minimum.

If the transmitter power is increased to 50W, (+3dB) then isolation must be increased the same amount, by +3dB, to 78dB.

In this example, look for a duplexer specified as having a minimum of 75dB isolation. Note that, depending on frequency spacing, the amount of isolation required may or may not be available.

As a rule, at VHF, 300kHz is the minimum channel spacing that can be used in any repeater system. At UHF, a minimum frequency spacing of 3MHz is required.

Impedance

The duplexer uses impedance differences to isolate the transmitter and receiver.

For example, two 50Ω resistors or 50Ω coaxial cables wired in parallel have a resulting impedance of 25Ω. (See Figure 1A on page 10.) When connected to another

50Ω device, the connection represents an impedance mismatch and results in a power loss.

When a 50Ω impedance circuit is connected in parallel with a 1Ω impedance circuit, the combined impedance is extremely close to 1Ω, almost a short circuit. (See Figure 1B.)

When a 50Ω impedance circuit is connected in parallel with a 10,000Ω impedance circuit, the combined impedance is extremely close to 50Ω, meaning that there is little effect upon the 50Ω circuit's impedance. (See Figure 1C.)

Duplexers are tuned devices.

They can present a 50Ω impedance at one frequency and either a lower or a higher impedance at another frequency. To provide isolation between two frequencies, a duplexer presents a short or an open circuit to a transmission line at a particular frequency. Energy at that frequency then either is removed from a transmission line or is prevented from traveling through the transmission line.

Next: Applications for types of duplexers are described to help you choose and configure cavities for specific purposes. Frequency bands and frequency separation play a part in selecting the cavities.

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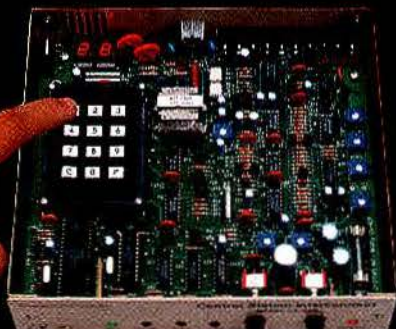
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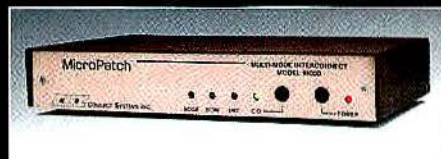
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Servicing pagers: Problems in paradise

Part 7—The hot sun is no friend of electronic equipment, and the Bravo pager is no exception. The 17.9kHz IF receiver board is the most susceptible to drift, especially in aftermarket cases. Here are some alignment tips.

By David Ludvigson

As was mentioned in last month's installment, making a five-transistor, one-chip radio receiver work reliably at 930MHz is quite a feat. When it comes to paging receivers, there is more to it than first meets the eye.

A side-by-side comparison of the NRF 4017A and NRF 4017E boards reveals many differences. (See photos 1 and 2 below.) The 45MHz IF "A" board has a gold-colored RF filter. The RF filter on the "E" board is slightly taller and silver-colored. The "E" board uses a 17.9MHz IF and has fewer components than the "A." There is also a glaring lack of "tech-tweakable" adjustments on the "E" boards; all that can be tuned is the antenna matching circuit (C552) and the oscillator frequency (L561).

Ludvigson is a technician in Houston.

Electronically, the two versions of this receiver are quite similar. The oscillator frequency first is quadrupled, then tripled, to provide an overall multiple of 12 times the crystal frequency. Although the 4017A and 4017B provide multiplier tuning, the 4017E does not have this feature. L564 and C570 are fixed-value components, generally resonant at around 304MHz.

Next, the 45MHz IF filter of the NRF 4017A is changed to 17.9MHz in the 4017E. This narrows the bandpass "window" for the incoming signal, making the oscillator tuning more critical.

After several months of working with the 4017E, I started noticing several customers having problems receiving their pages. In each case, they complained about a string of "Es" in their messages. (Displaying an E is the Bravo's way of reporting an error in data.) Every customer was using a pager with the NRF 4071 for a receiver. A few minutes spent aligning the oscillator was all that was required to bring back solid message reports.

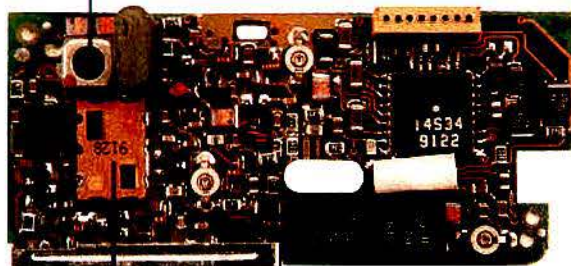
Pager servicing series

- Part 1: "Build A Shielded Room," January 1994. (All pagers.)
- Part 2: "Build An 'IFFER,'" February 1994. (Bravo, Bravo Plus, Bravo Express.)
- Part 3: "Frequencies, Coding Formats," March 1994. (Bravo.)
- Part 4: "From Bench To Programmer," April 1994. (Bravo.)
- Part 5: "The Receivers," May 1994. (Bravo.)
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- Part 7: "Problems In Paradise," July 1994. (Bravo.)

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Of utmost importance in any receiver design is the stability of the local

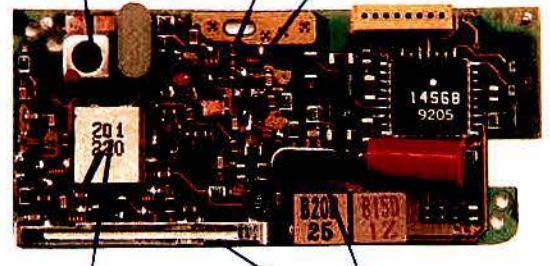
OSCILLATOR FREQUENCY
ADJUSTMENT (561)



RF FILTER FL551
IS GOLD-COLORED

Photo 1. The NRF 4071C board closely resembles the NRF 4071A board referred to in the text. NRF 4071A, NRF 4071B and NRF 4071C boards have gold-colored RF filters (FL551) and a 45MHz IF.

OSCILLATOR FREQUENCY
ADJUSTMENT (L561)



RF FILTER FL551 IS SILVER-COLORED AND SLIGHTLY TALLER THAN 45MHz BOARD FILTER

Photo 2. The NRF 4071E board has a 17.9MHz IF and a silver-colored RF filter (FL551) that is slightly taller than the filter on the A, B and C series boards.

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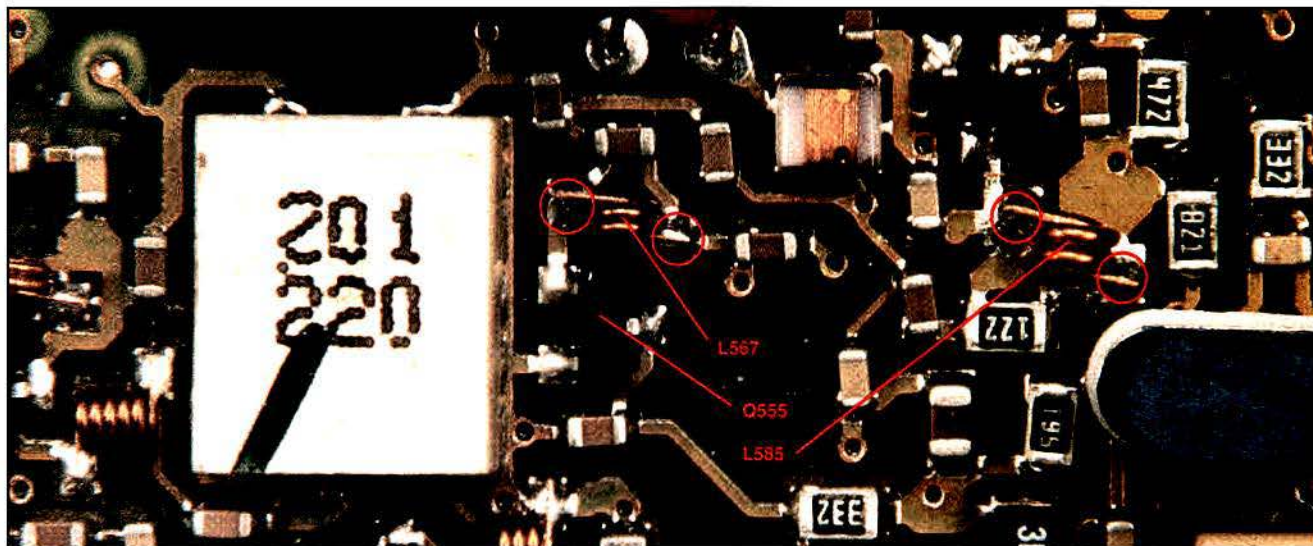


Photo 3. Poor performance of the NRF 4071E Q555 mixer stage often may be traced to poor soldering joints at either the base inductor (L567) or the collector inductor (L585).

oscillators and the bandpass characteristics of the IF. Should the oscillator drift beyond the bandpass window provided by the IF filter, the detected signal is going to be either above or below the range the decoder can handle. In short, the letter E will

become common in displayed messages.

Summer came, and outdoor temperatures rose higher and higher. Beach activity followed. Again the NRF 4071E began plaguing my bench. In some cases, the first conversion oscillator was off by as much

as 22kHz to 49kHz, and always on the high side. In each case, the customer had replaced the original black pager case with a semi-transparent after-market unit.

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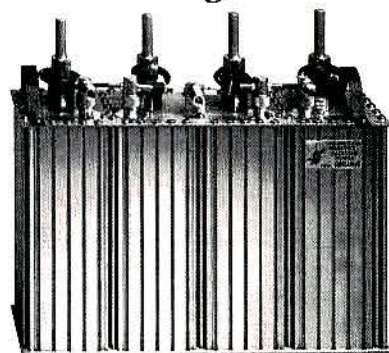
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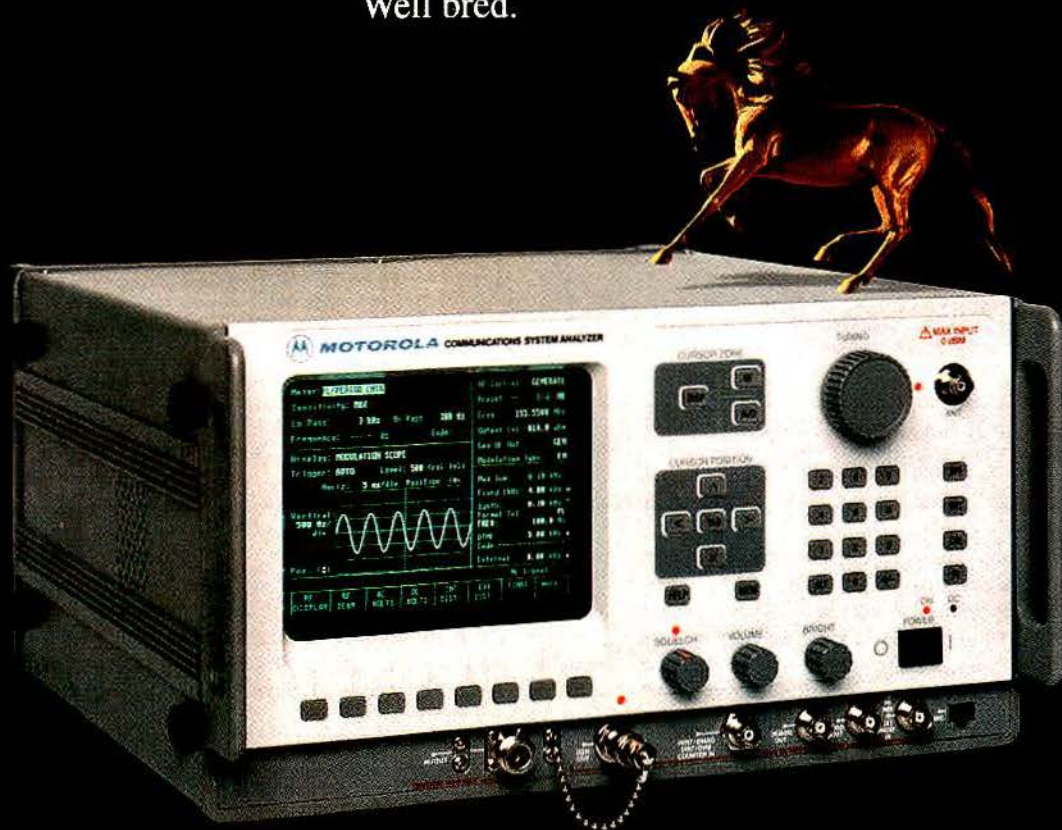
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MOTOROLA

Alignment procedure: Bravo NRF series (17.9MHz IF)

The following procedure deviates somewhat from the suggested Motorola technique and assumes the use of the shielded room (Part 1, January 1994 issue) and the IFFER (Part 2, February 1994 issue).

1. Set the signal generator to the exact frequency of receiver $[F_{\text{oper}} = (12 \times 1\text{st conv. xtal}) + 17.9\text{MHz}]$.

2. Frequency-modulate the signal with a 134Hz tone at 3kHz deviation.

3. Meter M1 using the IFFER and an oscilloscope. (See photo A below.)

4. Adjust L561 for the maximum peak-to-peak scope display with the 134.0Hz tone. (See photo B below.) This should be the first peak as L561 is adjusted clockwise as viewed from the foil side of the circuit board.

5. Reduce the signal generator's output level, and adjust C552 for maximum sensitivity.

6. Repeat steps 4 and 5 as necessary for maximum sensitivity and 134.0Hz reception. Output from the signal generator should read -90.2dBm ($<7\mu\text{V}$) for 1,200bps POCSAG and -92.5dBm ($<5.5\mu\text{V}$) for 512bps POCSAG. Measurements are signal generator output level readings applied through a 6dB attenuator to the RTL-1005 fixture.

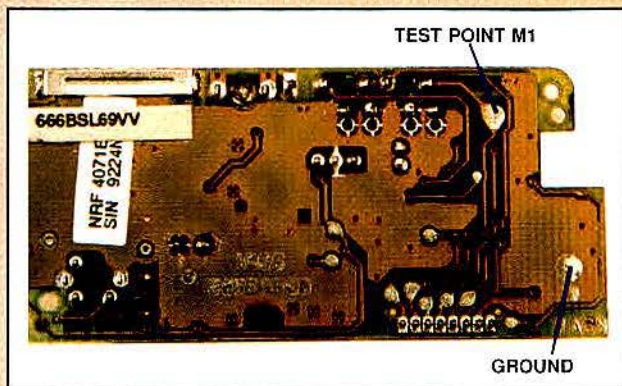


Photo A. Adjust the RTL-1005 test fixture's probes across the NRF 4071E receiver circuit board's test point M1 and ground.

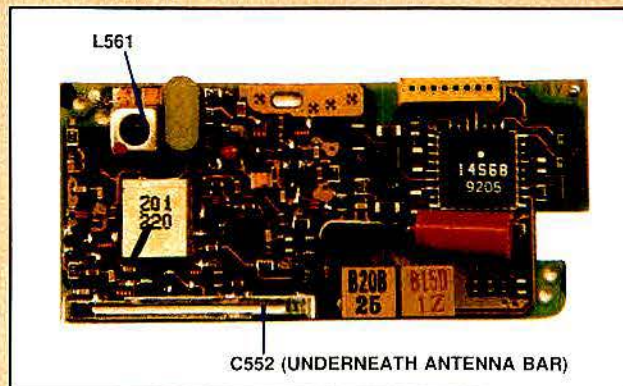


Photo B. These are the circuit adjustment locations for aligning the NRF 4071E receiver circuit board.

tell you that temperature changes cause frequency drift. At 76MHz, a $\times 12$ frequency multiplier converts a 4kHz oscillator drift to a 48kHz drift at the output. This drift is exacerbated further by users who clip their pastel pagers to the sun visors of

their cars in 100°F+ temperatures.

What effect does high temperature have on that fixed-tuned $\times 4$ multiplier stage? L564 and C570 are getting the heat treatment as well as the oscillator. These surface-mounted components have been

chosen to resonate around 304MHz—under ordinary circumstances. As the temperature increases, the components expand slightly, decreasing the actual amount of capacitance of C570, while also decreasing the inductance of L564. In short, the

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LC combination is changing its resonant frequency upward as well. This decreases the drive signal level to Q554, the $\times 3$ frequency multiplier. Output from the overall $\times 12$ oscillator-multiplier chain suffers, and the receiver sensitivity falls off. As the frequency drifts, the RF signal at the collector of Q555 moves closer and closer to the edges of the passband of the crystal filter (FL552) until the window is essentially shut, and the pager no longer receives pages.

Receiver boards NRF 4017A and NRF 4017B also tend to drift as temperatures rise. To its credit, Motorola selected com-

*Poor performance of the
Q555 mixer stage often
may be traced to poor
soldering joints at either
the base or collector
inductors.*

ponents with decent temperature coefficients to minimize this tendency. Furthermore, the $\times 4$ multiplier tuned circuit is capable of being optimized—literally, tuned to resonance—by the use of a variable capacitor in the 4017A and 4017B series. As another feature of these boards, the 45MHz IF is generally broad enough to tolerate a wandering oscillator.

Other caveats on the NRF 4017E must include the problems encountered with some components. Poor performance of the Q555 mixer stage often may be traced to poor soldering joints at either the base or collector inductors. (See photo 3 on page 16.) It seems as though little time may have been spent tinning these inductors before assembly, because they are notoriously difficult to solder.

Tuning the first conversion oscillator is fast. A single turn of the L561 inductor brings the oscillator to frequency—and several kilohertz beyond—with only a fraction of a turn. There simply is too much inductance here, and adjustment of this coil is critical. The permeability of the core or the number of turns of the inductor needs to be changed. Whatever, it is too touchy for the east Texas climate.



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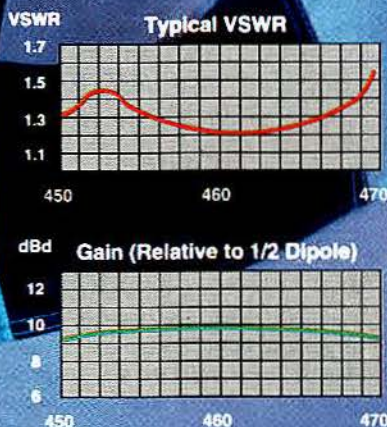
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Rechargeable batteries: Memory, self-discharge, battery conditioning

Part 3: Nickel-cadmium battery 'memory' and battery maintenance technology are explained in this installment, which concludes the series. Exercising and reconditioning can restore batteries to service.

By Isidor Buchmann

The first two installments explained and compared four battery chemistries, nickel-cadmium (NiCd), nickel-metal hydride (NiMH), sealed lead-acid (SLA) and lithium polymer.

NiCd batteries command the most popularity for use with portable radio communications equipment. Proper maintenance has much to do with keeping their capacity as high as possible and extending their life as long as possible.

Memory: Myth or fact?

There is some misconception about the word *memory*.

Memory commonly is blamed for just about any battery failure. The word *memory* is short for *cyclic memory*, referring to a condition in which a NiCd battery would lose capacity after having been placed through a series of shallow discharge and full recharge cycles.

This type of use causes physical changes in the battery that limit its discharge to less than its rated capacity. A battery exhibiting this *memory effect* seems to "remember" how much discharge was required on previous discharges.

Improvements in battery technology have virtually eliminated this phenomenon. Tests performed at a Black & Decker lab, for example, showed that the *cyclic memory* ef-

fects were so minute that they could be detected only by sensitive instruments. After the same battery was discharged for different lengths of time, the cyclic memory phenomenon no longer could be detected.

The problem with the modern NiCd battery is not cyclic memory but the effects of *crystalline formation*.

Hereafter, when we refer to memory, we are referring to the formation of crystals.

A NiCd battery's active materials (nickel and cadmium) are present in crystalline form. When the memory phenomenon oc-

the salt absorbs water, crystal formation can be observed.

Crystalline formation only presents a problem if the battery is left in the charger for days, or if it is repeatedly recharged without a periodic full discharge. It is not necessary to discharge a NiCd before each charge. A full discharge to 1V per cell once a month is sufficient to keep crystal formation under control. Such a discharge-charge cycle commonly is referred to as *exercise*.

If no exercise is applied for several months, the crystals ingrain themselves, making it more difficult to dissolve them. In such a case, exercise no longer is effective in restoring a battery, and *recondition* is required.

Recondition is a slow, deep discharge that drains the cell to a voltage threshold below 1V per cell. Lab tests have shown that the NiCd cell must be discharged to at least 0.6V per cell to dissolve the more resistive crystalline build-up.

Not all batteries respond well to recondition.

Let's examine a battery that has been in service for more than a year and that has not been exercised regularly. Its capacity reading may have dropped to a low 20%. Even with repeated recondition cycles, the battery may not improve to an acceptable capacity.

An older battery may even get worse with recondition. If this occurs, the battery is a candidate for retirement.

This type of battery may be compared to an old man to whom vigorous exercise is harmful. On the other hand, there are older NiCd batteries that, to everybody's amazement, recover to near-original capacity. Caution should be exercised when re-hiring these old-timers, as they may exhibit high self-discharge.

The crystalline effect on the NiCd cell plates is similar to the crystal formation that happens when calcium chloride is used to clear roads of ice or snow in the winter.

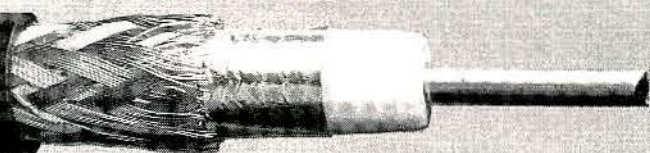
curs, these crystals grow, forming spike or tree-like crystals that cause the NiCd gradually to lose performance. In advanced stages, these crystals may puncture the separator, causing high self-discharge or an electrical short.

The crystalline effect on the NiCd cell plates is similar to the crystal formation that happens when calcium chloride is used to clear roads of ice or snow in the winter. As

Buchmann is the founder and chief executive officer of Cadex Electronics in Burnaby, British Columbia. He has been active in the radio communications sector and has studied the behavior of NiCd batteries in practical, everyday applications.

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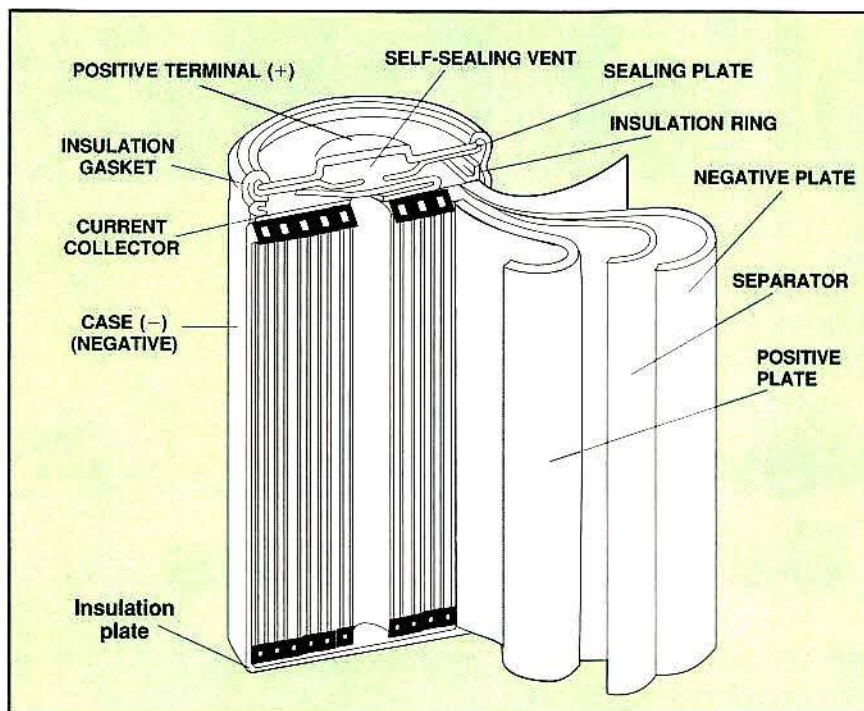


Figure 1. In a NiCd cell, negative and positive plates are rolled up together and placed into a metal cylinder. The positive plate is sintered and filled with nickel hydroxide. The negative plate is coated with cadmium active material. The two plates are isolated by the separator that is moistened with the electrolyte.

when re-hiring these old-timers, as they may exhibit high self-discharge.

Self-discharge

The NiCd and the NiMH have a relatively high self-discharge.

If left on the shelf, a new NiCd loses about 10% of its capacity in 24 hours. A problem arises if the self-discharge causes the battery to drain within a day.

High self-discharge is caused by a damaged separator. The separator is a thin insulator that isolates the positive and negative cell plates. A damaged separator cannot be repaired.

External forces that harm the sensitive separator include: uncontrolled crystalline formation due to lack of exercise, poorly designed chargers that boil the battery and plain old age.

Let's look at the NiCd cell construction. (See Figure 1 to the left.)

The negative and positive plates are rolled up together and placed into a metal cylinder. The positive plate is sintered and filled with nickel hydroxide. The negative plate is coated with cadmium active material. The two plates are isolated by the separator that is moistened with the electrolyte.

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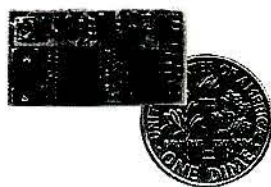
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To measure a battery's self-discharge, use a battery analyzer. First, the capacity of the fully charged battery is measured by applying a discharge. The battery then is stored for 24 hours, and the capacity is measured again. If the capacity loss is more than 30%, the battery should be discarded.

Battery analyzers are useful not only to measure self-discharge but, more importantly, to exercise and recondition batteries

to prolong service life. In addition, an analyzer is essential in identifying and weeding out weak batteries.

Battery analyzers

In the last few years, battery analyzer technology has advanced significantly.

No longer is the choice limited to analog units with fixed charge and discharge currents and programs that do nothing more than apply one or two discharge-

Rechargeable battery series

Previous installments in this article series include:

"Rechargeable Batteries: NiCd and Nickel-Metal Hydride" in the May 1994 issue.

"Rechargeable Batteries: Lead-Acid and Lithium" in the June 1994 issue.

Back issues printed within the past two years can be ordered for \$5 each, postpaid. Call customer service at 800-441-0294. Copies of articles printed more than two years ago are unavailable from the publisher.

charge cycles.

The modern battery analyzer in Photo 1 on page 28 evaluates a battery's condition and implements the appropriate cycles to maximize its performance. A recondition cycle is applied automatically if a set minimum capacity cannot be reached.

Battery chemistry, voltage and current rates are user-programmable. The battery code is stored in cups or cables and configures the analyzer to the correct function. More than 400 battery-specific cups are available.

The modern analyzer identifies battery packs with shorted, mismatched or soft cells. The derived battery capacity readings are organized into residual, intermediate and final capacities.

Problems, such as insufficient capacity reserve at the end of the work shift, can be identified and corrected easily. The voltage is displayed in numeric and bar graph formats.

The modern analyzer is able to charge and discharge the battery at user-defined currents. This feature allows testing the battery under true field conditions. A charge and discharge rate of IC* is as much as four times faster than that of a fixed-current analyzer. In addition, the capacity readings are more accurate with a modern analyzer.

The modern analyzer offers well-defined software that allows safe charging of all batteries, including those known to be faulty. Damaging overcharge on a pack with mismatched cells, for example, is eliminated.

The modern analyzer provides user-selectable programs to address the different battery needs. For example, PRIME

*C-Rate is a unit by which charge and discharge times are scaled. NiCd batteries with a rating of up to 1,800mAh are commonly charged and discharged at 1,800mA or 1C.



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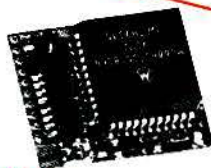
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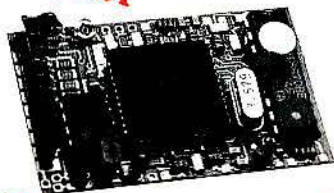
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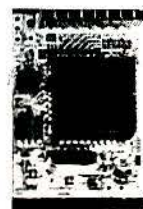
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Photo 1. The modern battery analyzer evaluates a battery's condition and implements the appropriate cycles to maximize its performance. A recondition cycle is applied automatically if a set minimum capacity cannot be reached.

prepares a new battery for field use, and AUTO reconditions those batteries that are unable to reach a set target capacity.

In addition, CUSTOM allows the operator to set a sequence of cycle modes

composed of charge, discharge, recondition, trickle charge or any combination. Rest periods and repeats can be added as required.

The modern analyzer is easy to use; the

software does the thinking. Capacity read-out in percentage rather than milliampere hours (mAh) is more convenient because the operator does not need to remember the mAh ratings of each battery tested. In addition, simple *pass/fail* lights help to differentiate good batteries from unserviceable ones at a glance.

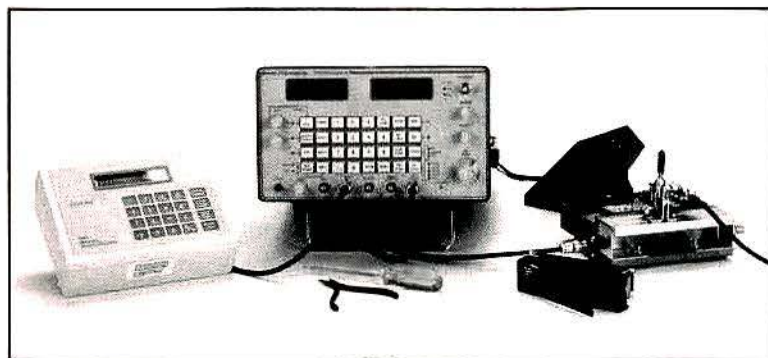
The modern analyzer offers a printer and computer interface. With a printer, service reports and battery stick-on labels with time and date can be generated. An RS-232 port allows a computer to store and process battery test results in a database and to produce charts and graphs.

The modern analyzer offers designated charge algorithms and specific cycle programs for different battery chemistries, such as the NiCd, NiMH and lead-acid. As new chemistries become available, EPROM upgrades should be made available to enable the servicing of these batteries.

(This concludes the article series.)



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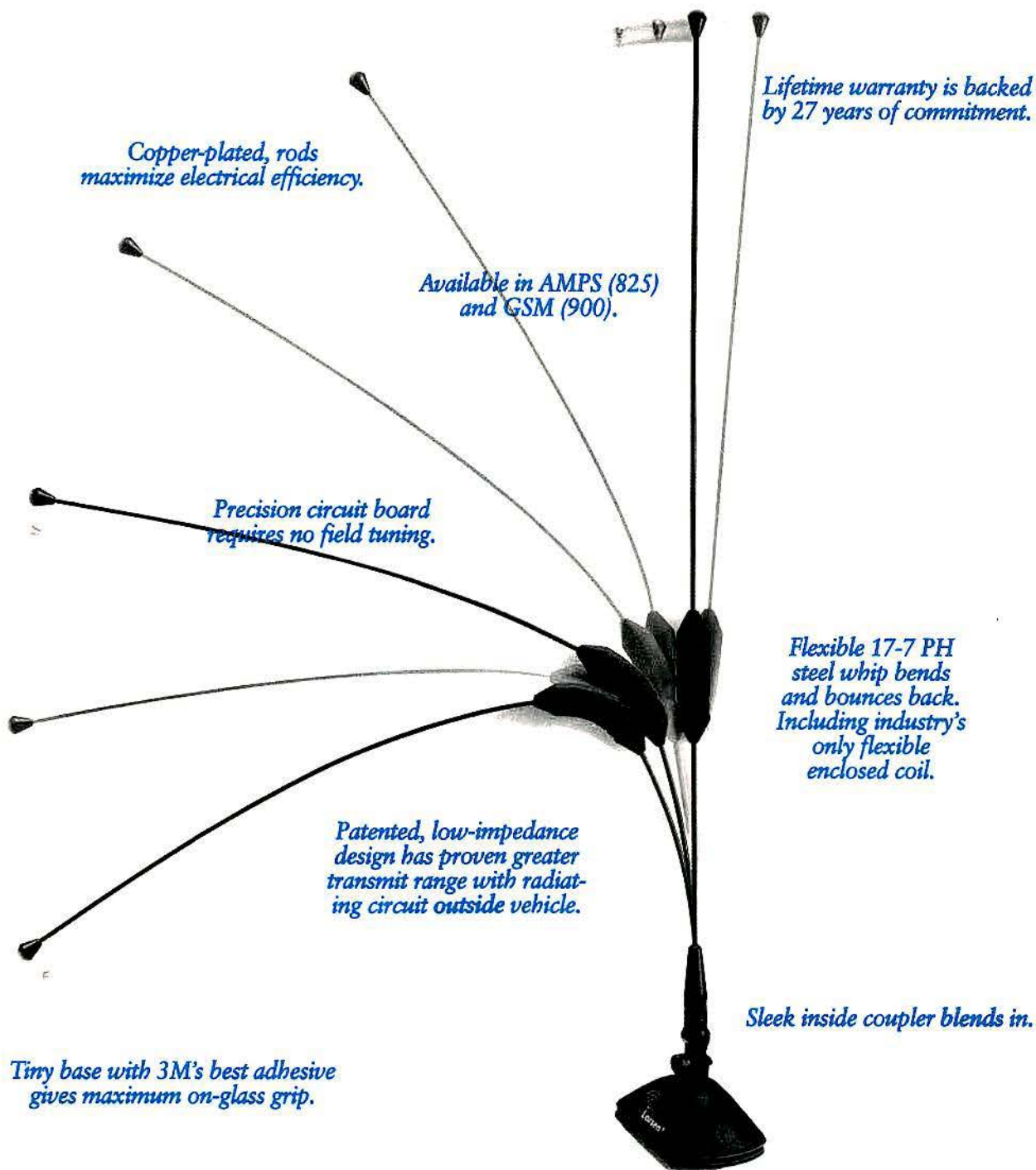
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Technically speaking

(continued from page 8)

and then apply Formula 2. We could apply Formula 4 for voltages across equal impedances. We could apply Formula 7 for currents in equal impedances. We choose Formula 4 for voltage ratios. Remember to use the same voltage units (millivolts or volts). Using voltage units and substituting into Formula 4, the calculator keystrokes are as follows:

1 \square 2 \div \square 1 \square LOG \square \times 20
 \square = 21.58362492

This result means that the output power is 21.6dB above the input power; or, simply put, the amplifier has a power gain of 21.6dB. Now let's apply the current formula (Formula 7) to the same problem, just to double-check the previous calculation.

Using microamperes (μ A) as the unit

of measure and substituting into Formula 7, the calculator keystrokes are as follows:

2400 \div 200 \square LOG \square \times 20
 \square = 21.58362492

This result verifies the accuracy of our first calculation.

Unequal input/output impedance

Refer now to Figure 2 on page 8. This figure is different from Figure 1 in that the input and output impedances are not the same. To calculate the power gain of the amplifier in decibels, either Formula 5 or Formula 8 must be used. On the other hand, if we are only interested in stating the voltage or current ratio in decibels, we may use Formula 4 or Formula 7. Remember that because the input and output impedances are not the same, the output/input voltage or current ratio in decibels will not be the same as the true output/input power ratio in decibels.

If you want to know the true output/input power ratio in decibels, use either Formula 5 or Formula 8 so that the different output/input impedances are taken into account. Technically speaking, the decibel originally was intended to represent only power ratios; nevertheless, the decibel can be used to represent voltage and current ratios as long as impedance is taken into account.

Some schematic diagrams in service manuals indicate stage gain in decibels. This stage gain is not true power gain. Instead, it is simply a comparison of output/input voltages in decibels without regard to the different output/input impedances.

Usually, an RF voltmeter is used to make stage gain measurements in the preparation of the service manual data. Usually, the same type of RF voltmeter is used to make such measurements in the shop. These instruments have scales calibrated in both decibels (relative to 1mW [dBm]) and volts (or millivolts). As long as the loading effects of the RF voltmeters are similar, the results are consistent. Thus, the use of decibels to indicate stage gain is valid even though it does not represent true power gain as decibels were intended to do. A voltage or current gain can be achieved even though a power loss may be incurred.

Getting back to Figure 2, let's calculate the voltage gain in terms of decibels and then the true power gain of the same stage. The voltage gain will be the same as for Figure 1; that is, 21.6dB. Even so, the power gain in decibels is found through Formula 5 or Formula 8. Using volts and ohms as units and substituting into Formula 5, the

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Technically speaking

calculator keystrokes are as follows*:

1 [.] 2 [x] [(] 500 [√] [)] [=]
 ÷ [(] . 1 [x] [(] 1000 [√] [)] [=]
 [)] [=] [LOG] [x] 20 [=]
18.57332496

Thus, the true power gain in decibels is about 3dB less than the voltage gain (in decibels) of the stage.

Correction factor

By using a correction factor to correct for the effects of unequal impedance, Formula 4 or Formula 7 can be used to convert voltage or current ratios to the equivalent power ratio in decibels. Remember these simple rules, and you will not go wrong. When using Formula 4 for voltage ratios, if the output impedance is higher than the input impedance, the *power* gain of the stage will be lower than the *voltage* gain in decibels. The opposite is true for current ratios. If the output impedance is

*On some scientific calculators, [√] (square root) entry is accomplished by the keystrokes [INV] [x²] (inverse, squared).

higher than the input impedance, the *power* gain of the stage is greater than the *current* gain expressed in decibels.

If you are using Formula 4 for voltage ratios across unequal input/output impedance, the correction factor can be calculated from this formula:

$$dB_c = 10 \log \left(\frac{R_i}{R_o} \right)$$

where

dB_c = correction factor

Be sure to observe the sign when applying the correction factor. The correction factor is simply added algebraically to the voltage ratio in decibels to obtain the true power ratio in decibels. If you calculate the correction factor (dB_c) for the voltage gain in Figure 2 it will be $-3dB_c$. Combining this correction factor with the voltage gain in decibels yields a power gain of: $21.6 - 3 = 18.6dB$.

If you use Formula 7 to calculate the current ratio in decibels when the output/input impedances are unequal, you must use the following formula to determine

the correction factor in decibels:

$$dB_c = 10 \log \left(\frac{R_o}{R_i} \right)$$

where

dB_c = correction factor

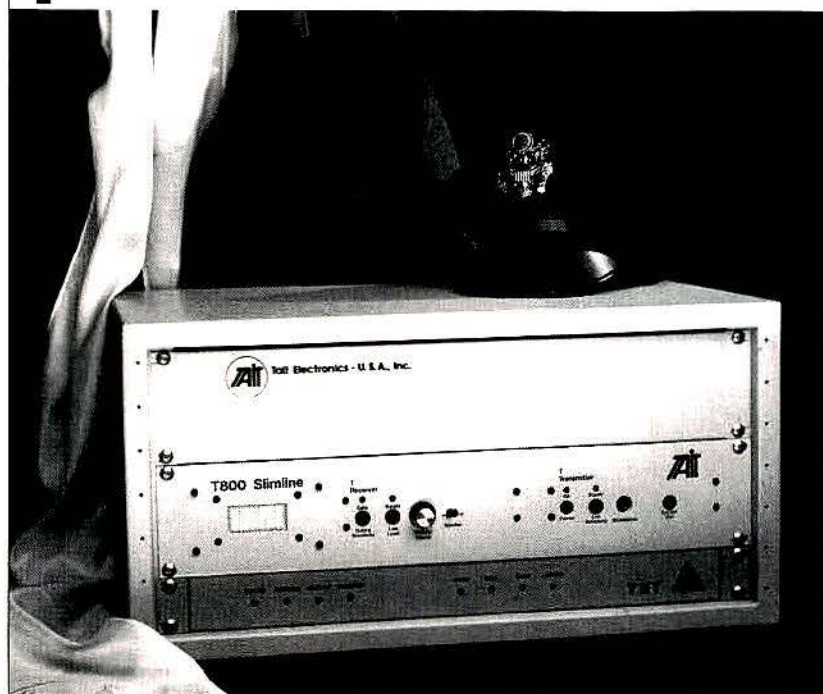
Again, the correction factor is simply added algebraically to the current ratio in decibels to obtain the true power ratio in decibels. If you calculate the correction factor (dB_c) for the current gain in Figure 2, it will be $+3dB_c$. Combining this correction factor with the current gain in decibels yields a power gain of $15.6 + 3 = 18.6dB$.

$$\text{Power ratio} = \text{antilog} \left(\frac{dB}{10} \right)$$

$$\text{Voltage ratio} = \text{antilog} \left(\frac{dB}{20} \right)$$

$$\text{Current ratio} = \text{antilog} \left(\frac{dB}{20} \right)$$

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When fabricated with Andrew premium performance connectors, HELIAX coaxial cable assemblies optimize electrical and mechanical performance, protecting against EMI-RFI interference and intermodulation. And HELIAX coaxial cable is highly flexible, weatherproof and durable.

Highly flexible,
shape holding solid
copper conductor

Closed-cell foam-dielectric
ensures low loss

New easy to attach connectors
deliver superior mechanical
integrity

Premium platings minimize
intermodulation

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HELIAX® Cable... The Global Leader in Cellular Communications

Circle (30) on Fast Fact Card

WHEN IT COMES TO DTMF... NOBODY DOES IT BETTER!

MODEL NC401

MICRO-MINIATURE DTMF DECODER

Three Decoders in one unit offering multiple user configurable output functions through microcontroller technology.

MODEL NC421

MULTI-FUNCTION DTMF DECODER

Enclosed in smartly styled plastic case with illuminated membrane control panel for mobiles.

MODEL NC4000

MULTI-FUNCTION DTMF DECODER

For control of remote applications, available with enclosure or 56 pin edge connector and a variety of options.

MODEL NC4004

MULTI-FUNCTION DTMF REPEATER

Capable of controlling 10 outputs while sensing 10 external inputs.

MODEL NC404

SUB-MINIATURE DTMF ENCODER

Digitally synthesized tone generator.

MODEL NC409

MICRO-MINIATURE DTMF ANI ENCODER

Exclusive Alarm and Man-Down features plus Transmit time-out timer, busy channel lock-out and microphone mute are only a few of the many features available in this microcontrolled unit.

MODEL NC410

NEW...DTMF ANI ENCODER DESIGNED WITH THE RCC IN MIND!

Simplifies telephone interconnects. 15 memory locations, last number redial, automatic connect/disconnect sequences and programmable "transmit refresh" provide easy operation in any mobile application.

**Call 1-800-874-8663
for complete information
and pricing.**



12438 Loma Rica Dr., Grass Valley, CA 95945

Circle (31) on Fast Fact Card

Technically speaking

The formulas on page 32 can be used to convert power ratios, current ratios and voltage ratios in decibels back to the equivalent simple *ratio* form. For example, to find the power ratio from the power gain of 18.6dB, use the formula for power ratio on page 32. Power ratio = antilog 18.6/10 = antilog 1.86 = 72.4,

Absolute values

Up to now, the decibel has been used as a means of comparing two power, voltage or current levels. The decibel can be used as an indication of absolute level as long as a reference is given or understood. For example, if we say that an amplifier has a gain of 15dB we still do not know what the output power is, unless we know the input power. If the input power level is given, the output power level can be computed.

In radio communications work, there are many reference levels by which the dB can be used to indicate exact voltage or power level in a circuit. For example, in 600Ω telephone lines, the *dBm* is an absolute signal level using the decibel as an indicator. The *m* in *dBm* indicates that the 0dB reference level is 1 milliwatt. The *dBm* unit also is used in 50Ω systems to indicate signal level. The voltage level corresponding to 0dBm in any impedance is found from the formula:

$$E = \sqrt{PR}$$

where

E = voltage

P = power

R = resistance

For 50Ω impedance, the voltage corresponding to the 0dBm level is:

$$E = \sqrt{50(0.001)} = \sqrt{0.05} = 0.223607V \\ = 223.6mV = 223,607\mu V$$

For 600Ω impedance, the voltage corresponding to the 0dBm level is:

$$E = \sqrt{600(0.001)} = 0.774597V = 774.6mV$$

To convert a 50Ω dBm level to a voltage level in microvolts across 50Ω, use the following formula:

$$\mu V = \text{antilog} \left(\frac{\text{dBm} + 107}{20} \right)$$

where

impedance = 50Ω

To convert a 600Ω level to a voltage level in millivolts across 600Ω, use the following formula:

$$= \text{antilog} \left(\frac{+57.8}{20} \right)$$

where

impedance = 600Ω

To convert a voltage level across 50Ω to the equivalent dBm level, use the following formula:

$$\text{dBm} = 20 \log \left(\frac{\mu V}{223,607} \right)$$

where

impedance = 50Ω

To convert a voltage level across 600Ω to the equivalent dBm level, use the following formula:

$$\text{dBm} = 20 \log \left(\frac{\mu V}{774.6} \right)$$

where

impedance = 600Ω

Power levels can be converted to dBm levels easily. For example, to convert 100W to dBm, use the following formula:

$$\text{dBm} = 10 \log(1,000P)$$

where

P = watts

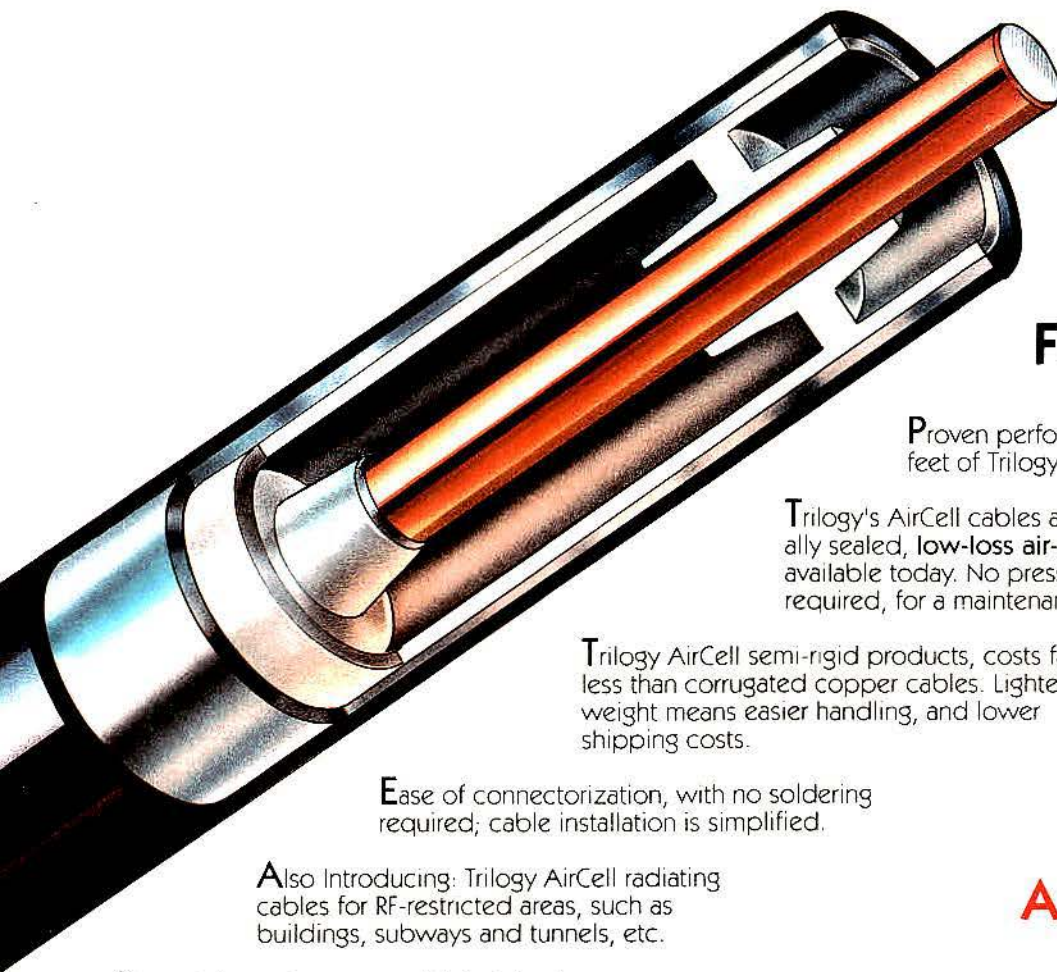
The following example illustrates how convenient it is to work with decibels.

Problem: The output from a transmitter is 100W. The transmission line loss between the transmitter antenna and the transmitter is 2.5dB. The transmitter has a gain of 3dB. The path loss between the transmitting and receiving antenna is 150dB. The receiving antenna has a gain of 5dB in the direction of the transmitter antenna. The transmission line loss between the receiving antenna and the receiver input is 3dB. What is the signal level at the receiver input in dBm? In microvolts?

TRILOGY

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THE QUALITY ALTERNATIVE IN
WIRELESS COMMUNICATIONS



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Proven performance with over 1.5 billion feet of Trilogy products installed worldwide.

Trilogy's AirCell cables are the only hermetically sealed, low-loss air-dielectric cables available today. No pressurization is required, for a maintenance free system.

Trilogy AirCell semi-rigid products, costs far less than corrugated copper cables. Lighter weight means easier handling, and lower shipping costs.

Ease of connectorization, with no soldering required; cable installation is simplified.

Also Introducing: Trilogy AirCell radiating cables for RF-restricted areas, such as buildings, subways and tunnels, etc.

All AirCell products are available in both 50Ω and 75Ω.

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Trilogy**

SENDING THE RIGHT SIGNAL



Trilogy 
COMMUNICATIONS INC.

Call or write for additional information:

TRILOGY COMMUNICATIONS INC., 2910 Highway 80 East, Pearl, Mississippi 39208
(800) 874-5649, (601) 932-4461 / FAX (601) 939-6637

Circle (32) on Fast Fact Card

Midland is making a serious "bid" for your portable radio business.

Midland's Syn-Tech XTR™ 70-195/295's are incredibly rugged, high tech, high spec 2-way FM portables for demanding operational requirements. Programmable up to 99 channels. 40 channel/second priority scan. Voice encryption and signaling options including digital selective call, ANI and status reporting. But it's tough to judge radios of this class from written specs alone. You need to actually use one. That's why we're making a special "bid" to put an evaluation sample in your hands, set up the way you want it, for field testing in your own system environment. Ask for your "Sealed Bid" offer from Midland LMR. **Call or fax today!**



MIDLAND LMR
LAND MOBILE RADIO

1-800/MIDLAND (Ext. 1690)
In Canada: 905/839-1700
FAX: (816) 245-1144

© 1993, Midland International Corporation

Circle (33) on Fast Fact Card

Technically speaking

Solution: The transmitter output is first converted to dBm as follows:

$$\text{dBm} = 10 \log(1,000P) = 50 \text{ dBm}$$

From this 50dBm power level at the transmitter, simply add the system gains and subtract the system losses to get the final signal level in dBm at the receiver input:

Transmitter output	+50.0dBm
Transmitter line loss	-2.5dB
Transmitter antenna gain	+3.0dB
Path loss	-150.0dB
Receiver antenna gain	+5.0dB
Receiver line loss	-3.0dB
Signal level at receiver	-97.5dBm

The signal level in microvolts is:

$$\mu\text{V} = \text{antilog} \left(\frac{\text{dBm} + 107}{20} \right)$$

$$= \text{antilog} \left(\frac{-97.5 + 107}{20} \right)$$

$$= \text{antilog} \left(\frac{9.5}{20} \right) = 2.99 \mu\text{V}$$

There are many other ways in which the decibel is used with a reference level to indicate an absolute power or voltage level. The information presented here can be applied to other situations in which the decibel might be used.

A computer program (IBM-compatible) that makes many computations of decibel formulas is available from the author for \$10 including shipping and handling. Specify 3½" or 5¼" floppy diskettes. You may write the author at 204 Tanglewylde Drive, Spartanburg, SC 29301-2949. *Stay tuned!*



HIGH Q FILTERS NOTCH AND BANDPASS

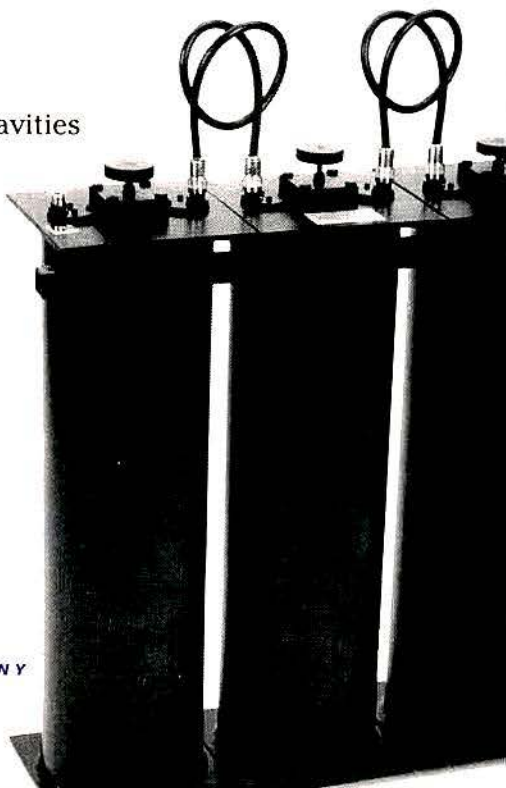
- Low loss
- Broad frequency range
30-950 MHz
- Single, double & triple cavities
for spot or wider band
attenuation
- Excellent power
handling &
temperature stability
- Field tunable

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request our data sheets
for HIGH Q FILTERS.

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MICROWAVE FILTER COMPANY

6743 KINNE STREET
EAST SYRACUSE, NY 13057
800-448-1666 • 315-437-3953
FAX: 315-463-1467



Circle (34) on Fast Fact Card

ATTENTION

PUBLIC SAFETY ANNOUNCEMENT

Tampering with Motorola's communication software is nothing short of a crime.

Motorola has been at the forefront of communications technology for more than 60 years. Today, we offer a greater array of communications products than ever before. We are proud of our products and the vital services they bring to our customers which are of unparalleled public importance.

Theft and unauthorized copying of Motorola communications radio software is illegal.

Motorola intends to combat this conduct by aggressively maintaining and enforcing its proprietary rights to its software technology. Anyone who has knowledge of such illegal activities or has questions concerning such activities is strongly urged to contact Motorola, Inc. immediately at 1-800-325-4036. Calls will be kept confidential and may be made anonymously.



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Circle (35) on Fast Fact Card

Product/services showcase

The following pages contain mobile radio products and services of advertisers in this issue. Information is provided by the advertisers. For more information on these products, circle the corresponding Fast Fact number found on the card on page 97. Also, refer to the Advertisers Index on page 96 for the page reference to the company's advertisement.



Jumper Cable Assemblies

Valuflex from **Andrew** is a new line of value-priced jumper coaxial cable assemblies designed to outperform braided cable assemblies. Ideal for radio equipment shelters, rack-to-rack and radio OEM applications. For information call 800-255-1479. Request Bulletin 1943A.

Circle (251) on Fast Fact Card



Public Safety Consoles

Zetron's public safety product line includes a broad array of dispatch consoles, console furniture, encoders, fire department alerting systems, instant recall reporters, TDD equipment and ALI displays. Factory technical training for dealers is available. Contact Zetron for more information.

Circle (252) on Fast Fact Card



FM Two-way Radios

Midland LMR offers two-way FM radios including mobiles, portables, base stations and repeaters in all land mobile bands. These range from the versatile Midland Syn-Tech advanced-technology, frequency-synthesized, conventional radios to the high-speed, digital, 800MHz Midland CMS trunked systems and equipment.

Midland LMR

Phone: 800-MIDLAND
In Canada: 905-839-1700

Circle (253) on Fast Fact Card



UHF Four-cavity Duplexer

TX RX Systems' model 28-70-02A pseudo-bandpass duplexer uses the patented Vari-Notch circuit to provide maximum isolation for the lowest insertion loss possible. Fully temperature compensated and manufactured to the highest standards, this duplexer will provide years of unequaled and trouble-free performance.

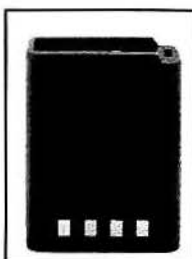
Circle (254) on Fast Fact Card

Scrambling for MicroTAC

Portable telephone security, invisibly embedded into Motorola MicroTACs, is activated with a simple keypad combination. Proven Crypto Voice Plus technology from **Transcrypt** is compatible with its other scramblers for complete cellular and office security.

Call 800-228-0226.

Circle (255) on Fast Fact Card



NiCd Replacement Batteries

The 7.5V replacement NiCd battery for the Uniden SPS Series Radio is available from **Centurion**

International. As with all Centurion battery packs, these new packs are made to exacting standards. Centurion model SP1100 at 1,000mAh capacity will replace the APX1100 for the Uniden SPS series radio. For more information, contact the sales department at 800-228-4563.

Circle (256) on Fast Fact Card



Analog and Digital Test Set

The 4032 Stabilock test set from **Schlumberger Technologies** supports all digital cellular formats. It will test TDMA, GSM, JDC at 800MHz and 1.5GHz, CDMA (in 1995) and PCS-1800 at 1.8GHz (August 1994). It also includes a high-speed, high-resolution spectrum analyzer.

Circle (257) on Fast Fact Card

Refurbished pagers

Get more beep for your buck with refurbished pagers. **Natcom** carries a complete line of quality refurbished pagers along with expert repair service from its Kern Pager Repair subsidiary. Refurbished models include Motorola and NEC pagers, with volume discounts available. Call 800-844-5376 for more information.

Circle (258) on Fast Fact Card



Bi-directional Amplifiers

Celwave

bi-directional amplifiers extend two-way communications in RF-shielded environments. All nine models have built-in circuitry to protect against oscillation damage and intermodulation distortion. Use rack-mounted or in a NEMA 3R enclosure cooled by a thermally activated fan. DOC-certified for 800MHz-900MHz SMR/public safety bands.



Celwave

2 Ryan Road, Marlboro, NJ 07746-1899
800-321-4700

Circle (259) on Fast Fact Card



Battery Support System

Christie Electric's microprocessor-based, programmable, ReFlex Casp/1200 supplies charging current for fast, safe charging of communications batteries, plus a slope-sensing charge termination feature which extends battery life. The system quickly analyzes capacity and, through its reconditioning function, electrochemically rejuvenates badly faded NiCd batteries. A serial output printer allows battery condition to be recorded.

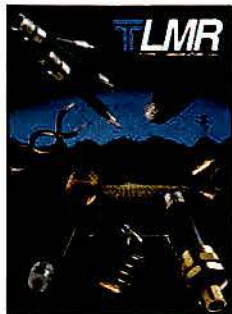
Circle (260) on Fast Fact Card



TDMA Radio System Tester

Motorola's Test Equipment Products' R-2660 Communications Analyzer is a high-performance platform providing compatible testing of Motorola's Integrated Radio System (MIRS) TDMA radio systems. The unit incorporates the power and design ergonomics of the Motorola R-2600 with additional MIRS-specific test capabilities to ensure peak operating performance.

Circle (261) on Fast Fact Card



Free Coax Selection Guide

Attenuation, power handling, dimensions and prices of several manufacturers' common cables are referenced in a free guide from **Times Microwave**. It features TMS's new LMR low-loss cables, a cost-effective choice for system interconnects and antenna feeders.

Call 800-TMS-COAX.

Circle (262) on Fast Fact Card

Heavy-duty Trunking Antenna

Built for applications requiring extraordinary reliability, the Hustler HD12-80669 from **Newtronics Antenna** offers 12dBd gain in a 1.9"-diameter radome. Wind survival is 150 m.p.h. Maximum power is 600W continuous. Down-tilt is available at no cost. Call the sales department at 800-949-9490.



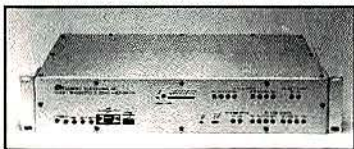
Circle (263) on Fast Fact Card



Increase Paging Saturation

Henry Radio paging amplifiers make up for filter/combiner losses and increase paging system saturation. VHF models are rated at 250W-300W continuous output. UHF models produce 180W-220W. Thermally controlled fans provide cooling. Contact Henry Radio, 2050 Bundy Drive, Los Angeles, CA 90025, or call Mr. Ted S. Henry at 800-877-7979, ext. 310.

Circle (264) on Fast Fact Card



Transmitter Steering Controller

The **Combined Technologies** TSAM-1 transmitter steering controller works with existing comparators and receiver voting electors to steer eight transmitters. It includes fully programmable control tone generation and CTI's exclusive Smart-Steer algorithm. It is expandable to 64 transmitters.

513-595-5900

See us at APCO booth 642

Circle (265) on Fast Fact Card



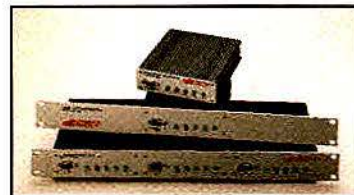
Mobile Signal Analysis

The STI-9000 improves radio frequency signal coverage measurement and analysis. It generates contour plots of measured results to provide system engineers a quick and accurate means of analyzing signal coverage over a wide area.

Survey Technologies

7980 S.W. Shadyside
Beaverton, OR 97007
Phone/FAX: 503-591-5986

Circle (266) on Fast Fact Card



Shared Repeater Tone Panel

Desktop/Rackmount
157 Subscribers, 51 CTCSS/106 DCS
DSP enhanced decode and talk-off rejection
CW ID per subscriber
Time and hit counter
Local/Remotely programmable (DTMF/Menu-driven RS-232)

Communications Specialists

800-854-0547 FAX 800-850-0547

Circle (267) on Fast Fact Card

Product/services showcase



Monitor for Wireless Communications Systems

IFR Systems' COM-120A features a crossband duplex, a split-screen spectrum analyzer and a high-resolution EL display. The RF generator and receiver screens display all UUT information, along with a scope or spectrum analyzer. Signaling includes CTCSS, two-tone sequential, DCS and DTMF.

800-835-2352

Circle (268) on Fast Fact Card



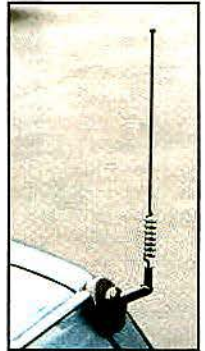
LANCERnet Low-cost Trunking

Trunk conventional radio equipment with affordable, feature-rich network systems. Complete control of multiple channel mobile telephone systems. Local Area Network Central Exchange Radio (LANCER) offers: automatic channel allocation, intersystem privacy, conference and group calling, and much more. For information contact **CES** at 800-327-9956.

Circle (269) on Fast Fact Card

Cellular Look-alike Antennas Hatchback Adaptor

STI-CO's hatchback swivel adaptor is a practical option for non-elevated feed trunk-lip mount, disguised cellular look-alike antennas. It fits most hatchback cars, vans and 4-wheel drive sports vehicles and can be used with STI-CO's antennas. Quick and easy to install.



Circle (270) on Fast Fact Card

Base Station Cable

UltraLink TL93605 from **Cushcraft/Signals** is an extremely low-loss, moisture-resistant cable. It features a large solid copper center conductor covered by a closed cellular foam dielectric at 89% velocity of propagation, a 100% non-glued foil shield layer, 95% braided shield layer and a black PVC jacket.



Circle (271) on Fast Fact Card



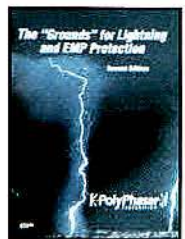
Smaller-sized Paging Station

The **Nucleus** Paging Station from **Motorola's** Global Paging Infrastructure Division has new surface-mount technology to reduce station volume by as much as 80%. Nucleus offers 4-level modulation for next-generation paging signaling schemes. Codes include the European Radio Messaging System (ERMES) and Motorola's Flex. Nucleus also processes 2-level modulation for POCSAG pagers.

Circle (272) on Fast Fact Card

Grounding Installation Guide

The second edition of *The "Grounds" for Lightning and EMP Protection* is now available. This 100-page publication is a comprehensive, hands-on guide to proper grounding installation, measurement and maintenance for direct lightning strike survival.



Polyphaser

P.O. Box 9000
Minden, NV 89423
800-325-7170

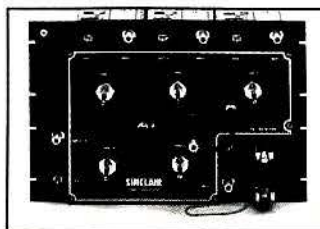
Circle (273) on Fast Fact Card



Radio-telephone/Selective Call

Midian provides two custom products for Maxon SP2000/SL70 portables. Features include a DTMF radio-telephone encoder/decoder/ANI/transponder with optional 10-code inversion scrambler, 16-channel trunking scan and a multicity trunk listing; or a multitone, multiformal ANI/selective call encoder/decoder module with optional 10-code inversion scrambler.

Circle (274) on Fast Fact Card



Transformer Combiners

Available in expandable 5-, 10- and 20-channel versions. **Sinclair Radio Laboratories'** RTC-800 series covers the 851MHz-866MHz trunking frequency band. Easy installation with simple field tools and test ports for on-air transmitter checks. The unit requires a minimum of rack space and is UPS-shippable.

Circle (275) on Fast Fact Card



Programmable battery analyzer

The **Cadex** C4000 battery analyzer services NiCd, NiMH and SLA batteries. Over 700 battery adapters are available for portable radios, cellular phones, etc. User-programmable "smart" cables accommodate less-common batteries. NiCds affected by memory are commonly restored to full capacity.

Circle (276) on Fast Fact Card



Video Modem

Communications Specialists' video modem sends broadcast quality, single-frame, color video over any narrow-band communications channel. Any NTSC-compatible video source can be used at the sending end. Use two-way radio, cellular, satellite or landlines for transmissions.

800-854-0547

Circle (277) on Fast Fact Card



Monitor Guards Base Stations

Wireless telecommunications field technicians can't be everywhere at once. The Sentry 8000 series remote site monitors from **Decibel Products** can be. Every hour of every day, Sentry monitors the valuable equipment contained in a base station shelter, and the shelter itself, for fire, intruders or power outage.

Circle (278) on Fast Fact Card

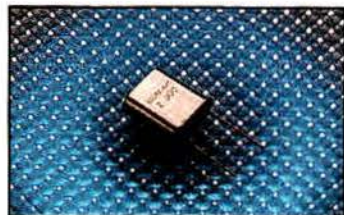


Numeric Pagers

The **Fact Sports II** numeric pager from **NEC America** has an eight-message capacity with 20 digits per message, a clock and time stamp, four programmable alert options and

one-button control. VHF, UHF and 900MHz models are available. Signal format is POCSAG code, binary digital, non-return to zero. Incoming pages are automatically illuminated on the display. The pagers are available in six distinct colors.

Circle (279) on Fast Fact Card



Pager Crystals

Bomar's new line of high-reliability 900MHz pager crystals are here. The product line features crystals for Bravo, Bravo Plus, Express and Advisor pagers. Bomar builds each crystal to precise specifications, and each comes totally aged for clean, drift-free reception. Bomar crystals carry a lifetime guarantee. For more information call 800-526-3935, or FAX 800-777-2197.

Circle (280) on Fast Fact Card



Paging Encoders

Zetron offers a full line of reliable encoders to fit nearly any paging application. The encoders are field-programmable from their own keypads, simplifying set-up and maximizing versatility. Digital display and analog formats may be mixed in the same encoder, and even Electron formats are supported.

Circle (281) on Fast Fact Card



Connector/surge protector

Arrestor Plus from **Andrew** is a new, one-piece connector/surge protector that protects personnel and equipment from repeated and potentially damaging effects of current induced by lightning strikes. Compatible with all standard connector interface types. For information call 800-255-1479 to request Bulletin 1982.

Circle (282) on Fast Fact Card



Now Available from SFD:

Base Station Antennas
Combiners/Duplexers
Mobile Antennas
Coaxial Cables & Connectors
Lightning Protection
Power Supplies Towers

Santa Fe Distributing, Inc.
913-492-8288 or 800-255-6595
FAX: 800-255-6596

Circle (283) on Fast Fact Card



High Q Bandpass Filters

A new series of high Q bandpass filters offers tunable quarterwave cavities in a variety of diameters for increased Q, selectivity and low loss while suppressing interference from 30MHz to 950MHz. Available from **Microwave Filter**, these filters can be used as preselectors or to clean up spurious transmit signals. Five different sizes are available in single, double and triple cavities. The units have rotating loops and an adjustable resonator for field tuning.

Circle (284) on Fast Fact Card



Mixed-lot Battery Charging

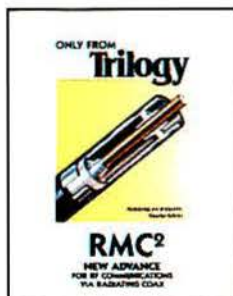
MasterCharger 6 from **W&W Associates**

charges six different batteries simultaneously—with different voltages and capacities, NiCd or nickel-metal hydride. Battery models from different manufacturers can be mixed. One or all six charging positions can be changed to accommodate various transceiver battery types.

Circle (285) on Fast Fact Card

Product/services showcase

Air-dielectric Radiating Cables



Trilogy Communications introduces RMC² radiating cables for RF-restricted areas (buildings, subways, tunnels, etc.). Product

features include: the only hermetically sealed low-loss air-dielectric cables available and they require no pressurization. No soldering for connectorization, and RMC² costs far less than corrugated copper cables. Available in 50Ω and 75Ω.

Circle (286) on Fast Fact Card



Motorola Pager Housings

Buy genuine pager housings from **Motorola** at great new prices. Remember, non-Motorola housings void your Motorola warranty because they may be of inferior quality and damage internal circuitry. Avoid technical problems and keep your Motorola pagers functioning with genuine Motorola replacement parts. Call 800-892-3068.

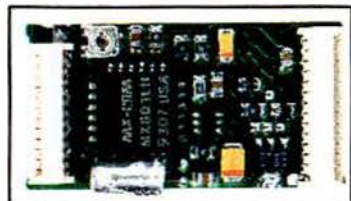
Circle (287) on Fast Fact Card

NiCd Replacement Batteries

Multiplier Industries introduces rechargeable nickel-cadmium replacement batteries for Motorola Radius GP300 two-way radios. Multiplier's

part #M9808 rapid charge, 7.5V, 600mAh battery, and part #M9628 rapid charge, 7.5V, 1,200mAh battery, meet or exceed OEM specifications for form, fit and function.

Circle (288) on Fast Fact Card



CAD Fleet Management

MX-COM's CADi Computer-aided Dispatch system encodes and decodes two-way radio SelCall tone signals to make a fleet safer and more efficient. The system features easy-to-use software, ANI, status reporting, emergency alarms and OTAR.

Call MX-COM at 800-638-5577.

Circle (289) on Fast Fact Card



Alarm Page Processor

Telemessaging Device's MR-31 processes calls as many as 400 low-cost, remote alarm dialers to send as many as 1,600 different messages (50 characters alphanumeric or numeric) to a paging system using the TAP format. Uses include site monitoring and revenue-generating alarm messaging service.

Call 800-645-4595

Circle (290) on Fast Fact Card

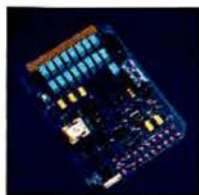


Solar Power Supply

Hutton's solar power supply "mini" series is available in sizes of 1W-hour/day to 230W-hours/day depending on the type of battery and solar module. 230W-hours represents continuous operation of a 25W repeater talking for two hours per day. For more information, call 800-442-3811.

Circle (291) on Fast Fact Card

Mutli-function DTMF Controller



Norcomm's NC4000 is a uniquely designed 16-channel DTMF encoder/decoder for control and status reporting of

remote applications or as a compatible replacement for Speedcall's model C527 decoder. The NC4000 features 11 operating modes, three power-on and alarm configurations, 0-8 digit address, E²Prom memory and more.

800-874-8663

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Two case histories of EMI/RFI solutions

Communications devices in vehicles may interfere with one another. Tracing the cause can involve documentation, customer consultations, equipment substitutions, brainstorming with other techs and vendor assistance.

By Donald E. Koehler

I had just crawled out from under the dispatcher's console when the radio crackled with my call sign.

"OK," I said. "What's up?"

"Call the shop boss, the base commander's car is back."

The phone call confirmed my worst fears. The installed VHF transceiver had been locking up the day before. My shop had spent about four hours on it but came up with CND (could not duplicate).

Intermittent troubles caused by *electromagnetic incompatibility* (EMI) or *radio frequency interference* (RFI) can be some of the most vexing to solve—especially if the system belongs to your most important customer.

I ran back to the shop and then had one of the shop technicians use our database to pull up the maintenance history for the commander's car. I quizzed the other tech on exactly what had been done.

I had been "selling" the local hospital commander on moving his paging operation onto our system for shared saving; thus, I had been out of the shop for quite a while. I had made that "sale," but I may have lost my most important customer.

"So, tell me exactly, and in what order, every little thing you did yesterday," I asked the tech.

Documenting the problem

The tech thought for a moment, then listed his actions:

First, he had picked up the car from the base commander and ran it over to the shop. He had carefully questioned the user upon pickup, per our standard practice. He

then wrote down the user's description of the symptoms. In this case, the VHF transceiver "locked up" on channel 4 while in *scan* mode.

Then, with the car back at the shop, he had shut off all of the systems, the engine and any accessories. With everything dead, the ignition switch was set to *acc*. The VHF transceiver was turned on, then switched to scan. No lockup was noted. He wrote this down.

He started the engine and ran the check again—no lockup. He switched on additional systems and noted the results.

The car was equipped with:

- (1) a VHF transceiver, the victim.
- (2) a military air-to-ground (A/G) UHF transceiver.
- (3) a signaling system (PA, siren, grill lights) hooked into the VHF transceiver.
- (4) a secure cellular telephone.

Still CND. He then pulled the radio set

and turned it over to the base LMR contractor, requesting a complete checkout.

Tracing leads

While the contractor ran the radio through its paces, both shop technicians traced the power, RF and sense leads back to the source. They cleaned the power leads at the battery, checked both sets of fuses and verified that no cuts, nicks or holes were present.

The routing of power leads was well away from any EMI/RFI-identified "black boxes" (more on this later) under the hood, and the routing did not cross or follow other system power leads. The sense lead from the harness to the fuse block was checked and cleaned, and the bypass capacitors were checked visually. Everything was OK.

The transceiver came back from the on-site contractor with a clean bill of health. Channel 4 had even been completely checked twice—power, SINAD, noise and squelch level, all right on factory specifications.

"Heck Don, I even went over to the other radio shop, borrowed a 'scope and checked the alternator output for 'hash' (wideband electrical noise)," the technician said, in a puzzled tone of voice. "Remember, we had the motor pool install that 100A alternator? I wanted to make sure it wasn't noisy."

"What did you find?" I asked.

"Clean as a whistle," he shook his head. "What did I miss, boss?"

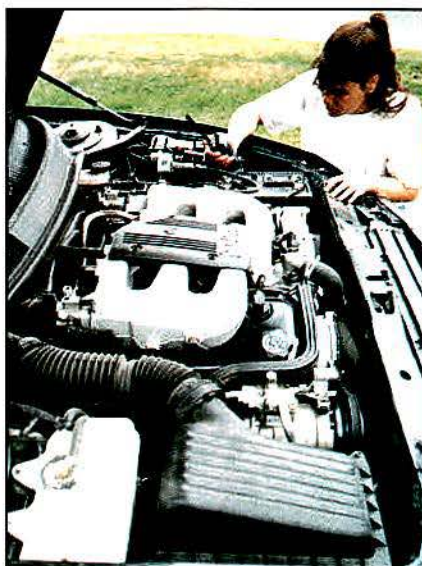
"Not much, I'm sure," I replied.

I asked the other tech, "What did the database show?"

He was just as puzzled. "Well, not much. The old cellular was replaced with the secure one about two weeks ago."

Consulting the customer

Armed with all of this information, I called the base commander and asked if I could bring the car back and talk to him.



An apprentice installer uses a scanner to check for EMI/RFI hot spots.

Koehler is the owner of Communication Specialties, Anchorage, AK.

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An apprentice installer checks out trunk area prior to installation of trunk mount system.

A time was agreed upon, and soon I was face-to-face with the owner. We had worked together in the past and had established a level of trust needed by all providers.

I took a few minutes and explained what had been done to date. The commander

was impressed, and said so. This commander had a well-deserved reputation for attention to detail, even to checking the inside of the hubcaps for cleanliness during vehicle inspections. He expected no less from those who worked for him, the same as any customer. I asked him to ac-

company me to the shop to make a couple of tests, and he agreed to do so.

Duplicating the problem

Back at the shop, I asked the technicians who worked on the car to come outside and, in front of the commander, repeated the positive comments he had made. Then, asking them to watch, I turned back to the commander and asked, "Sir, would you please use your communications systems to talk to somebody here on base?"

He grinned and made a series of calls. Finally, the cellular was put to use. In the *clear* mode, no problem was observed, but in the *secure* mode, the VHF transceiver locked up on channel 4.

Bingo. Or so I thought.

Finding a noise source

One of the technicians gave the commander a lift to his office while the off-fending system was examined. I went back inside the shop and picked up my ICOM IC-2SAT hand-held and dialed in the channel 4 frequency.

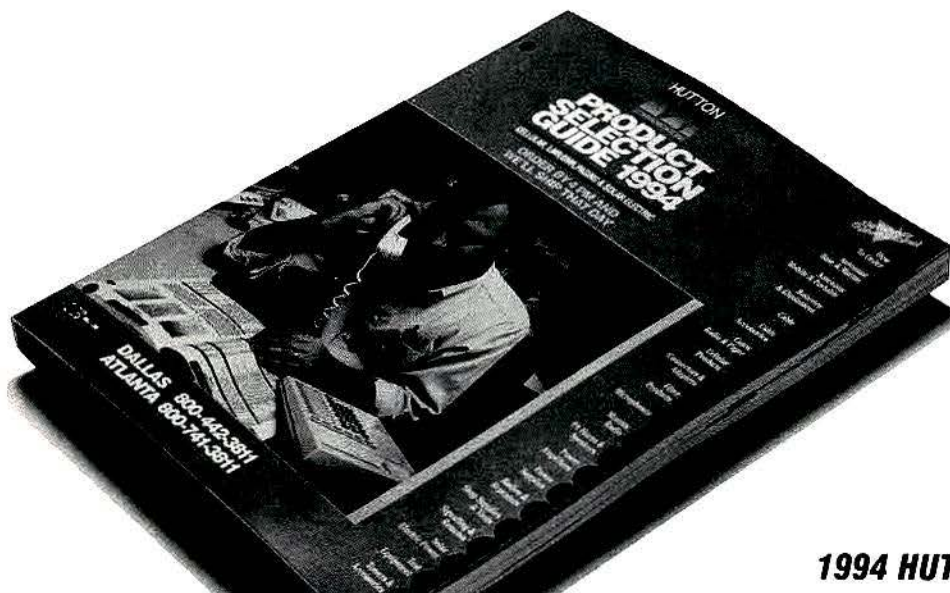
Returning outside, I circled the car. The windows were up, and the engine was running. I listened to the hand-held as I walked around the car. I put the hand-held

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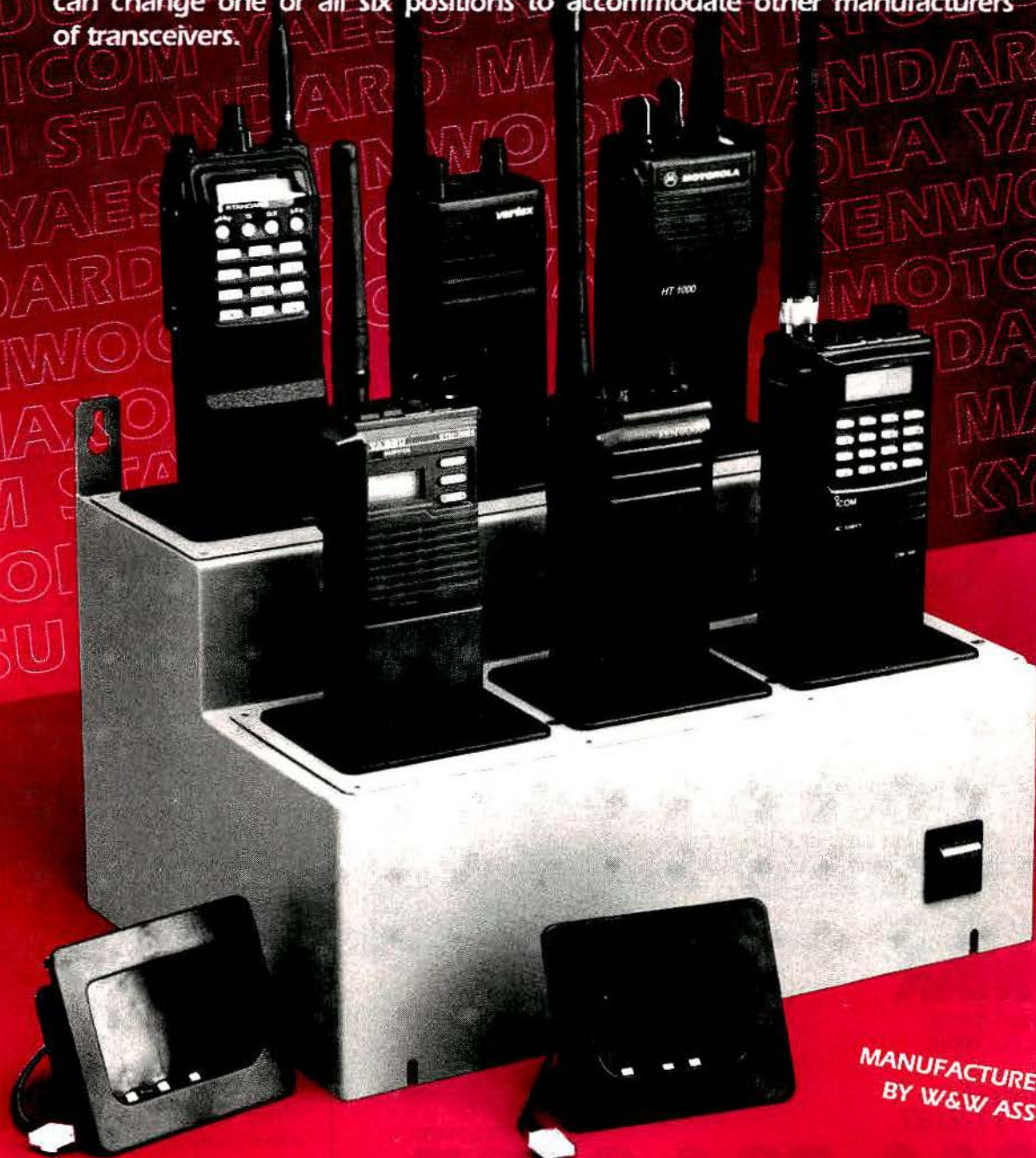
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near all of the external antennas, hearing nothing.

Then, with the hood raised and while watching out for the moving parts, I swept the antenna near the battery and power leads. Near the previously identified "black boxes," the hand-held made the expected noise.

Then I opened the door, and the hand-held started picking up even more hash.

I moved the scanner near the dash and

the signaling system and picked up no noise.

I moved the scanner near the land mobile and A/G radios, where I picked up some noise, but the noise moved the received signal strength display off the scale when I placed the hand-held near the cellular control head.

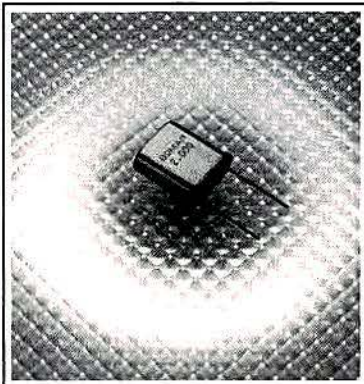
With the IC-2SAT antenna removed, the display dropped back down scale. A bit more work showed that the greatest



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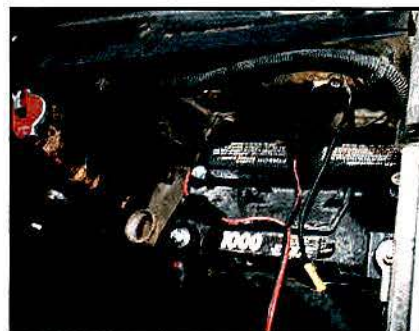
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Poor installation practices cost money on callbacks and dissatisfied customers, and they are a hazard.

amount of hash indeed was emitted from the cellular head, *but only with the telephone in the secure mode.*

Vendor assistance

When contacted by telephone, the vendor who had installed the cellular telephone expressed disbelief. The system was TEMPEST approved, so it couldn't possibly radiate, according to the vendor. When I said that my next call would be to the vendor's national headquarters, he agreed to send a tech right away.

The vendor's technician soon arrived. When presented with my findings, he replaced the cellular set with a spare unit. The problem disappeared.

The suspect cellular set was returned to the factory for examination. The car was returned to the base commander. His only comment was, "Good show."

I went back to the shop and wrote down all of the details—after all, nobody is forever.

Lessons learned

What lessons did my technicians learn from this adventure?

First, when faced with a possible intermittent problem, let the customer or user *show you* what they see as the problem.

If it is a training problem or operator



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The COM-120A

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error, you have caught it right away with little lost time. My technicians, in an effort to please the customer, had overlooked this most important step. About 16 to 18 man-hours had been spent, with no results to show.

They did write down the symptoms and all of the steps—with results—of work performed. If we had billed by the hour or job, this kind of detail would make service reporting easier. This information also can be entered into a database for

baseline reference.

Second, although the effort to check the power system was thorough, it was not productive.

Nothing had changed; no work had been done under the hood; no new battery had been installed; no new radios had been installed. The cellular set had used the previously installed power leads, so no indication warranted the effort. Known EMI/RFI sources had been avoided.

Newer cars have multiple sources of

wideband noise. Standard practice at my shop was to use a hand-held scanner to see whether the installed equipment took any direct hits, that is, noise peaks on installed equipment operating frequencies. More on this in a later article. Careful routing, bonding the equipment to the vehicle ground or chassis helps to control this EMI/RFI monster.

Logic tree

Problem solving would lead the tech down the "logic tree" from the start. Start with: What is new or what is different?

In this case, a review of the database would have fingered the new secure cellular phone.

Next, when did it go bad?

Later discussion with the owner indicated that all of the required cryptographic keys had only recently been installed, so use of the secure mode was not possible until just a couple of days before. In addition, the user did not always use the scan mode; thus, the appearance of the lock-up problem was delayed.

To be fair, the technicians did a bang-up job in eliminating all other possible problems before I got directly involved. Only my experience with wideband computer noise gave me the ability to *connect the dots*, so to speak.

Did I overlook anything?

You bet. I did not ask about the commander's use of his portable equipment, including a Saber 3 land mobile radio, a portable cellular phone, a pager and a laptop computer, all of which might have affected the problem.

What to do?

Education is a big key, including reading articles such as this and promoting a positive, sharing atmosphere at the shop to help everyone to focus on all possibilities.

When facing a problem, stop to think for a few minutes, talk about the problem with others and brainstorm for ideas. Fifteen minutes of sharing ideas can be more productive than spending many man-hours without results.

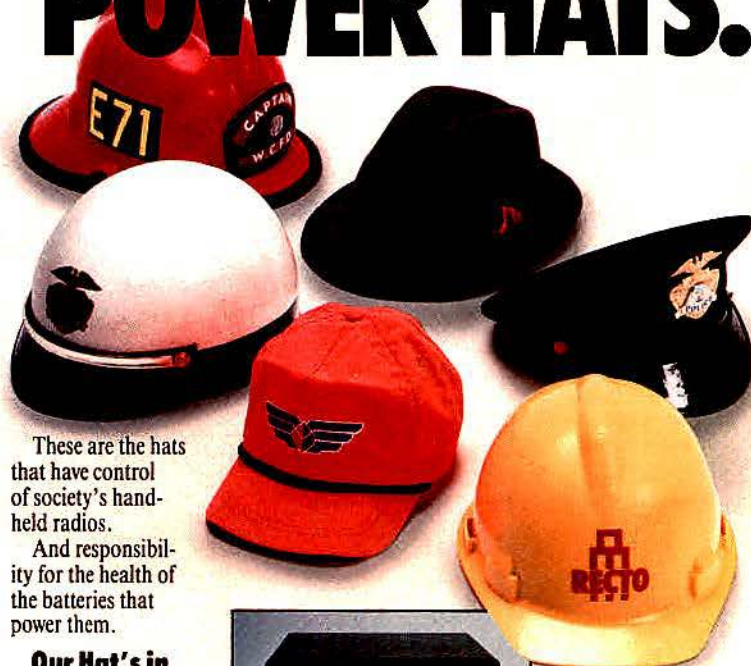
Customers who are involved in the troubleshooting process are far more tolerant of problems than those who are left in the dark. It helps to build a strong customer relationship that makes the difference between a profitable shop or one that goes under.

The silent telephone

In our next case, we had just finished installing a UHF transceiver in a customer's pick-up truck.

I had been working weekends at a local land mobile radio shop to supplement my military pay. The installation checked out

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OK, so we dropped off the truck and called it quits.

The next day, the shop owner called and asked me to come in that evening. I found the pick-up truck parked in the service bay.

"What's up, boss?" I asked.

It seems that after the UHF radio had been installed, a VHF mobile radiotelephone, already in the truck, had quit working. Because the customer was a building contractor, this result was not acceptable.

Just fix it

My part-time boss was a good salesman, but not a tech. He turned it over to me and said, "Fix it before you go home. I don't care how late you stay. Just get it fixed!"

OK, now what?

I called the truck owner and asked him to describe the problem.

The problem was two-fold, as he described it. He could receive phone calls, but when he went to answer, the phone went dead. When he tried to make a call, the phone went dead.

There had been no problem with the VHF mobile radiotelephone prior to the installation of the UHF radio, which worked just fine.

His final words were, "Fix the problem

or take out the new radio." That kind of solution is no solution at all, as far as a shop is concerned, because it not only represents a lost sale, but possibly an ex-customer who might spread the word about his experience.

A check of the VHF system transmitter showed normal power output to a dummy load and acceptable SWR into the installed antenna. The UHF radio had been bench-checked prior to installation, so it was a known good system.

Starting over

Now what?

Well, undo what I did. The power leads and antenna were disconnected from the UHF set. A short telephone call was made, and *everything worked just fine.*

Next, I hooked up the power leads to the UHF radio set and made another short call. Again, everything was OK.

Once again I attached the antenna to the UHF set. I tried to make another phone call, but nothing could be heard.

I walked over to the shop phone and made a call to the mobile phone. The phone in the truck buzzed, but when I picked up the handset, nothing could be heard.

By now, it was time to stop, drink a soda and noodle a bit. Something about the UHF radio being attached to its antenna caused the problem.

I checked the UHF set. Its power output and SWR were OK. The connector was new and well-soldered.

Substitution

I pulled the UHF radio and installed a spare from bench stock. The phone worked, but just barely.

I went back to the shop and found an older unit made by the same manufacturer, set it up on frequency, and then installed it.

Bingo. Everything worked just fine. Phone calls were made and received, and the UHF set banged into the repeater just fine. I shut down the shop and left a note for the boss to call me in the morning.

Over breakfast, I explained what I had found and strongly suggested he call the distributor about the UHF radio. Something in the newer sets was causing the problem. Both sets were sent to the factory, and the reply was terse. The PA decks on both sets were replaced under warranty, thank you.

A call to the factory revealed a bad production run on PIN switching diodes located in the PA decks. Apparently, when the VHF phone transmitted, some of the power was partially rectified and retransmitted. This caused the phone receiver to desense and drop out.

This diode problem was well-known at the factory, but no bulletins had been issued. When factory representatives received trouble calls, they admitted the problem, but only over the phone.

Lessons learned

The strangest things happen.

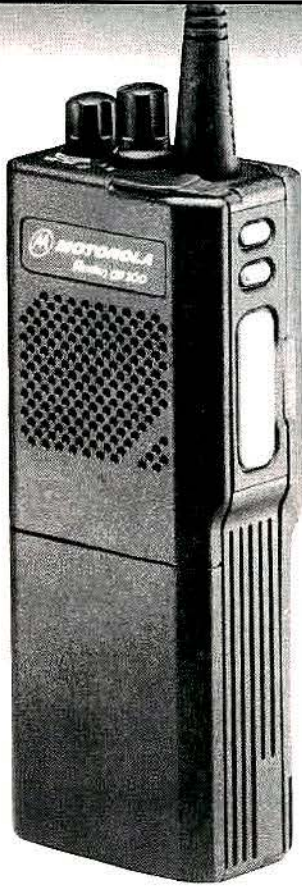
The only clue I had was the disconnected UHF antenna, and then only persistence in trying several radios led to the fix.

What to do?

It helps to define the problem as a statement, then take a few moments to search the service bulletin library every well-run shop has in place. If "no joy" is found in the library and if the budget can stand the drain, call the factory representative or other shops dealing in the product. Sharing information with other shops will not hurt your profit picture and should pay long-term benefits.

Remember, prevention is cheaper than a call back. Check my next article on analysis of potential problems and a listing of EMI/RFI shielding materials and products. 'Til then, remember to have fun.





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Dingell won't budge on budget

By Robert H. Schwaninger Jr.

Rep. John Dingell, D-Mich., is tough, powerful and a force to be reckoned with in American politics. He is the chairman of the House Energy and Commerce Committee, which, among other duties, over-

sees the operation and funding of the FCC.

Dingell, who can make the boldest lobbyist cringe and cower, now has taken the Office of Management and Budget (OMB) to task. In a letter to OMB director Leon Panetta, Dingell objects to the Clinton Administration's plan to use the money to be collected by the FCC to finance federal assistance to states that are

imprisoning illegal aliens for crimes committed in this country.

The FCC is predicted to collect about \$138 million in user fees and filing fees during fiscal year 1995, which begins Oct. 1, 1994. The law passed by Congress that directs the FCC to collect fees also states that the fees are intended to offset the agency's operating costs. In fact, the amount expected to be collected in 1995 closely matches the FCC's present budget.

But wait.

Another part of the OMB's plan would slash the FCC's budget to a scant \$72.5 million—about half the amount it would take to operate the FCC at its presently overburdened level. Does that mean that OMB wants to reduce the size of the FCC's resources by 50%? No. The OMB is suggesting that shortfalls be covered by increasing fees to licensees.

Dingell's letter, in effect, states that the administration's plan won't wash with the enabling legislation that allows the FCC to collect fees, doesn't jibe with the intent of collecting the fees in the first place, and simply is an inappropriate diversion of funds that should rightfully be used to improve telecommunications regulation.

Having met Rep. Dingell, and having followed his career in overseeing the FCC, I have been impressed with his ability to effect changes that he believed were appropriate for telecommunications. We have not always agreed. This time we do.

The FCC is underbudgeted both for historical reasons and for political reasons that can be traced to wrangling between past FCC chairmen and Capitol Hill. While politicians maneuvered for position, the FCC suffered budget decreases, employee cutbacks, equipment and resource shortages, and a general malaise resulting from there simply being too little of everything.

With the introduction of filing fees, there was renewed hope that the small amount collected would show a little black ink alongside the red to encourage Congress to loosen some purse strings. With the newly adopted user fees, the intent was that the agency actually would pay for itself. Finally, spectrum auctions hold out the promise that the FCC might be a real money maker for the federal government. In sum, it should have appeared



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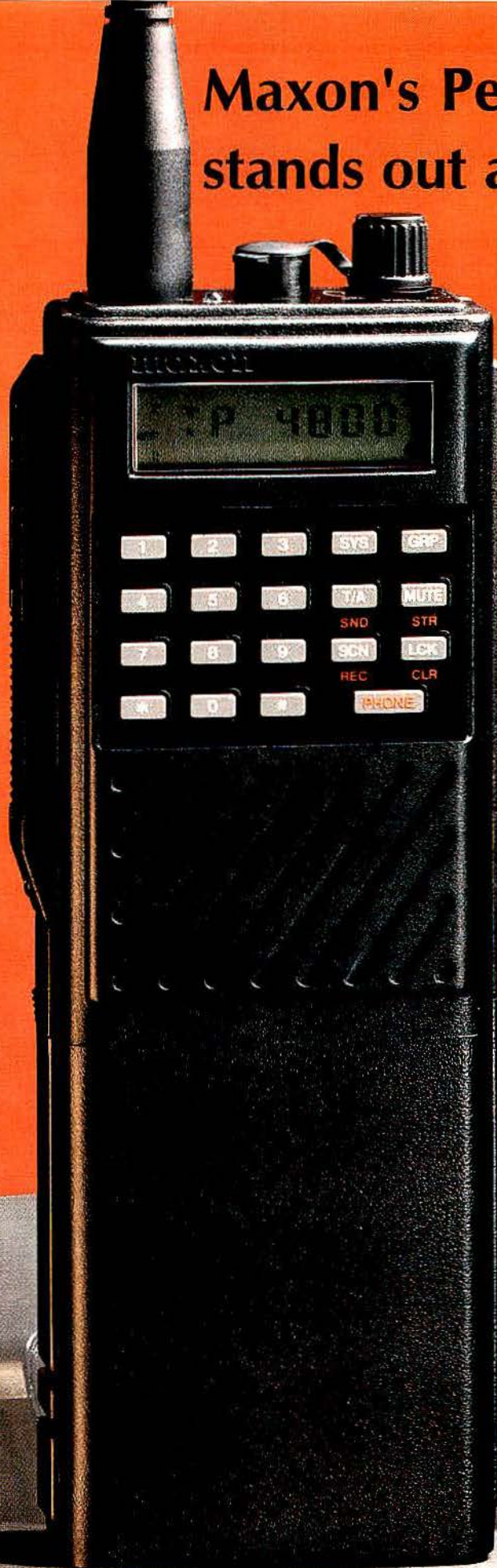
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Schwaninger, MRT's regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

Maxon's Performance and Quality stands out above the rest...



When it comes to 800 MHz Trunking Radios, Maxon's user friendly TP-4800 portable offers users higher performance than most other trunking radios in its class.

Side-by-side comparisons with higher priced 800 MHz radios, revealed that the TP-4800 had faster system access and an extended range of operation.

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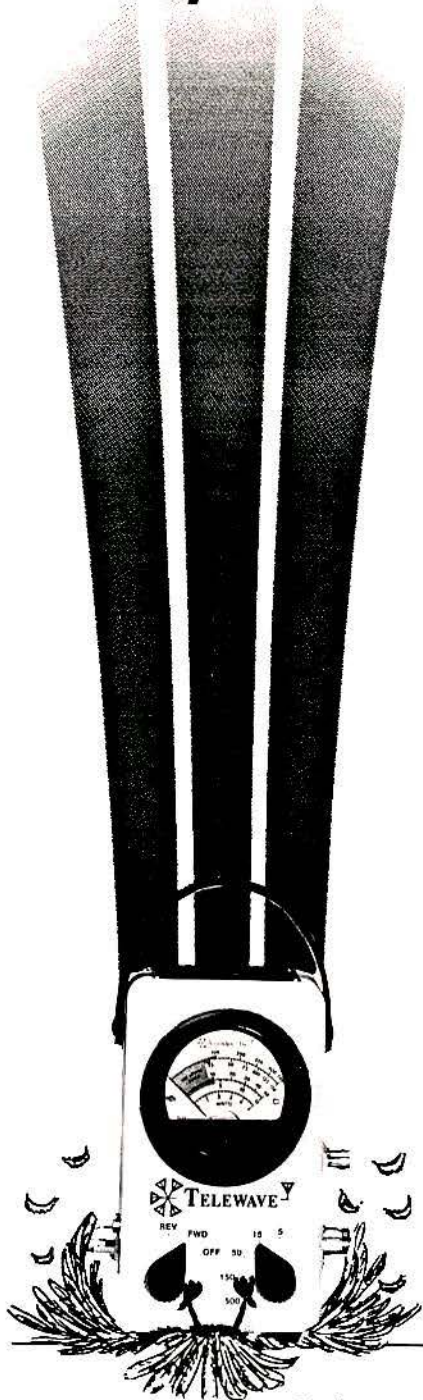
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Photo enlarged to show detail.

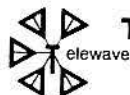
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Circle (47) on Fast Fact Card

Telewave's Broadband RF Wattmeter is rapidly becoming a new Industry Standard!



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Telewave, Inc.



Circle (48) on Fast Fact Card

Regulating technology

that telecommunications regulation might be a growth industry for the federal government and that further investment would be wise.

Wisdom, however, is often a scarce commodity in Washington. Is it wise to continually tax our industry without holding out a reward (or simple service) for our payments? Does it produce the necessary competitive spirit and encourage the entrepreneurial hearts that have pushed manufactured devices out of the nation's skunkworks and onto the shelves? Will FCC employees be encouraged to press on, despite the lack of resources, if they know their considerable efforts are being used to finance unrelated prison programs? Finally, will the OMB's scheme do anything to lower the prolonged processing time for a single application?

Consider this: The FCC could be expanded and financed for a decade for the price of a single high-tech bomber. More to the point, the prison program's operating cost is almost three times the FCC's operating cost! Somewhere along the line, priorities have been mixed up. Our industry's strength cannot be maintained by higher fees without commensurate higher-quality service. We deserve what we paid for and what we have been promised by the legislation that created filing, user, hearing, coordination and auction fees. The OMB should look elsewhere.

* * *

If you are a faithful reader of this column (Hi, Mom) you might notice that this month it is printed sans cartoon. My talented cartoonist quit for a variety of reasons, one of which may well be because he believes I am too controversial. The editor is seeking a replacement, presumably someone from the Weatherman Underground School of Art.

This is not the first time that I have been labeled "controversial." To see whether this label holds up, let's look at past and present columns. I have stated that:

- (1) some consumers have been ripped off by application mills.
- (2) Congress has failed to provide ad-

equate guidance regarding minority positions in future spectrum auctions.

(3) frequency coordinators should determine for whom they work.

(4) some dealers overcharge public safety entities for equipment.

(5) the FBI is going too far in forcing cooperation in future wiretapping activity.

(6) the OMB should look elsewhere for prison financing than to money that the FCC collects.

The cartoonist was correct. Questioning what goes on in Washington and the wisdom of actions that affect our industry leads me to controversy. Writing about it gives me the full credentials of "controversial figure." Actually stating an opinion about it is the final straw. I am guilty as charged.

Why is the charge of being controversial often leveled at me or at others within our industry who speak out? It is because of a dearth of opinion that challenges the way that the industry is regulated and operated, often to the detriment of the smallest entities. The largest entities will continue to make money and to gain advantage, but there is rarely an advocate for simple fairness who is concerned that Joe's Two-way Shop should not be driven out of business by unequal treatment and opportunity.

This column will not qualify me for sainthood. All hopes of that were erased when I became a lawyer, and sometimes "the law is a ass," as Mr. Bumble observes in Charles Dickens' *Oliver Twist*. This column allows one stubborn Missouri mule, relocated to Washington, DC, to talk to the telecommunications industry about issues important to all the Joes and AIs and Sams and Susies that he meets across the country. If that means being controversial, then you can decide whether the column is being written by a Missouri mule or a Washington, DC, jackass.

WJ

Need a "Quote" on an Interconnect?

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-- Bruce Vandenbos, B&L Comm.
Platte SD

"The service that we receive from Zetron is second to none. If every company were as good about helping us as Zetron is, it would make my job a lot easier."

-- Chris Young, West Tennessee Comm.
Dyersburg TN

"We certainly have used a lot of interconnects over the years. I would state that, as a rule, the Zetron products work perfectly. The back-up is fabulous."

-- Roger Combs, Frontier Radio
Las Vegas NV

"They're reliable. That's it in a nutshell. You can count on them. And the after-sales support is excellent."

-- Dave Tubergen, T&W Electronics
Grand Rapids MI

"The customer service is excellent. I would say it's tops in the industry. The interconnects are very programmable, adaptable to customers' needs. That's why we keep using them."

-- Dennis Korkowski, Brandon Comm.
Brandon MN

"You put them in and forget about them. We don't have any technical problems with Zetron interconnects."

-- Jim Reed, Ark Valley Comm.
Wichita KS

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Roamer One SMR network adds 120 license sites

Simrom has concluded negotiations to manage an additional 120 specialized mobile radio (SMR) licenses in the 220MHz frequency. The licenses, which are located throughout the United States, have been granted by the FCC to various individuals. Simrom will be responsible for the construction, loading and management of the systems on behalf of the licensees.

The licensees will be responsible for providing the capital funding required to construct and operate the systems. The estimated cost to construct all 120 of the proposed systems is \$11.4 million over an eight-month period.

With these new contracts, Simrom will have more than 300 sites in the United States under purchase option or manage-

ment contract. These sites will form the basis for a planned national SMR network in the 220MHz spectrum using narrowband technology for voice and data transmissions. The network will be known as "Roamer One."

Simrom is owned 60% by Roamer One, Cleveland, and 40% by Simmonds Communications, Toronto, Ontario.



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Dallas / Ft. Worth Farmers Branch, TX (214) 241-1891	Atlanta Decatur, GA (404) 981-5070	Midwest Schaumburg, IL (708) 576-5763	Motorola do Brasil São Paulo, SP Brasil 55-11-821-9991

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Circle (50) on Fast Fact Card

Intek, Simmonds Communications, Roamer One complete merger

Simmonds Communications (SCL), Toronto, Ontario; Roamer One, Cleveland; and Intek Diversified, Los Angeles, have finalized a merger. Intek will acquire the radio carrier business of Simrom, a joint venture between SCL and Roamer One, in exchange for the issuance to SCL and Roamer One of six million common shares of Intek. Roamer One will receive 3.6 million common shares of Intek, and SCL will receive 2.4 million common shares. Five million of these common shares will be held in escrow until the completion by Simrom of the initial build-out phase of the network.

NABER unveils electronic application transfer program

The National Association of Business and Educational Radio (NABER) unveiled NABER-Link, an electronic application transfer service, at its 1994 Mobile Comm conference.

Offered for both Windows and DOS, NABER-Link allows users to electronically file their FCC Form 574 for a Business Radio license to NABER coordination services. The service also provides users access to electronic bulletin boards and electronic-mail options.

"We anticipate that NABER-Link will reduce average coordination turnaround time for subscribers by about 35%," said E.B. "Jay" Kitchen, NABER president.

Company changes name to reflect scope of services

Raymond C. Trott Consulting Engineers, Irving, TX, has changed its name to Trott Communications Group (TCG). The company provides engineering services for the design, procurement and implementation of telecommunications and automation systems in both the private and public sectors.

Good Things & Small Packages



Yes, it's true! Good things **DO** come in small packages...especially at RELM Communications. RELM's new line of radios include some of the most compact mobile and portable radios available. These radios feature a wide variety of power and feature combinations to meet virtually every application. And, best of all, these small packages carry small prices, too!

SM Series Mobiles: (above)

- ▲ 40 watts power VHF (150-174 MHz)
- ▲ 25 watts power UHF (450-482 MHz)
- ▲ 16 or 99 channel capability with Scan
- ▲ Built-in CTCSS & DCS
- ▲ Extremely easy, user friendly operation

SL Series Mobiles: (above)

- ▲ 40 watts power VHF (150-174 MHz)
- ▲ 25 watts power UHF (450-482 MHz)
- ▲ 6 channel capability with pre-set squelch
- ▲ Built-in CTCSS, DCS & Two Tone Sequential

PT Series Portables: (above)

- ▲ 5 watts power VHF (150-174 MHz)
- ▲ 4 watts power UHF (450-512 MHz)
- ▲ 6 channel capability without scan
- ▲ Built-in CTCSS, DCS and Two-Tone Sequential — Great for Talk-Back Paging applications

WHS150 Portable: (left)

- ▲ 5 watts power VHF (148-174 MHz)
- ▲ 16 channel capability with scan
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Harris selects Coded Communications to develop NCIC-2000 terminals

Coded Communications, Carlsbad, CA, has been selected by Harris' Information Systems Division, Rochester, NY, as the provider for the mobile computer terminal platform for the National Crime Information Center-2000 (NCIC-2000) contract with the FBI.

Coded and Harris ISD are jointly exploring opportunities where they might

work together to serve customers interested in NCIC-2000-compliant integrated solutions for mobile data, imagery, computer-aided dispatch and message switching.

Designed to be accessed by more than 72,000 law enforcement agencies across the United States by 1995, the NCIC-2000 system will expand the existing system to

include real-time fingerprint matching against wanted persons files and imagery support for identification of persons and property.

The new units will feature built-in support for peripheral devices such as a mobile camera, fingerprint scanner, magnetic stripe card reader and bar code scanner and provide full-function MS-DOS or Windows 386 or 486 in-vehicle computing and digital communications.

Organization focuses on commitment to wireless

Women in Wireless Communications, a new organization to promote wireless education, foster wireless growth and address women-in-wireless issues, met for the first time at the recent International Wireless Communications Expo in Las Vegas. The group will address such issues as industry history, marketing, networking and wireless trends.

About 30 women attended the first meeting, and the group plans to meet various times throughout the year at industry events. Women in Wireless Communications is seeking sales and marketing professionals for its membership. Dues are \$25 per year. For information, contact Patty Offermann, membership chair, at Communications Associates, 815-744-6444, ext. 214.

Terminal, test gear makers win Motorola Flex licenses

The Motorola Paging Products Group, Boynton Beach, FL, has issued licenses to four manufacturers to make equipment in connection with its Flex high-speed paging protocol.

Advanced Signal, Quincy, IL, will make test and monitoring equipment to read, decode and capture the Flex data streams. Cromack Industries, Greenfield, MA, will make a go/no-go tester for Flex pagers.

Commonwealth Communications Industries, Ashland, VA, will make paging terminals. TGA Systems, Atlanta, also will make terminals, as well as paging system analyzers.

Quantum Publishing moves to Mill Valley

Quantum Publishing of Mendocino, CA, has moved its headquarters to Mill Valley. Its mailing address is now P.O. Box 1738, Mill Valley, CA 94941; 800-422-9666. The company is a publisher of wireless communications technologies resources.



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- ☐ internal battery

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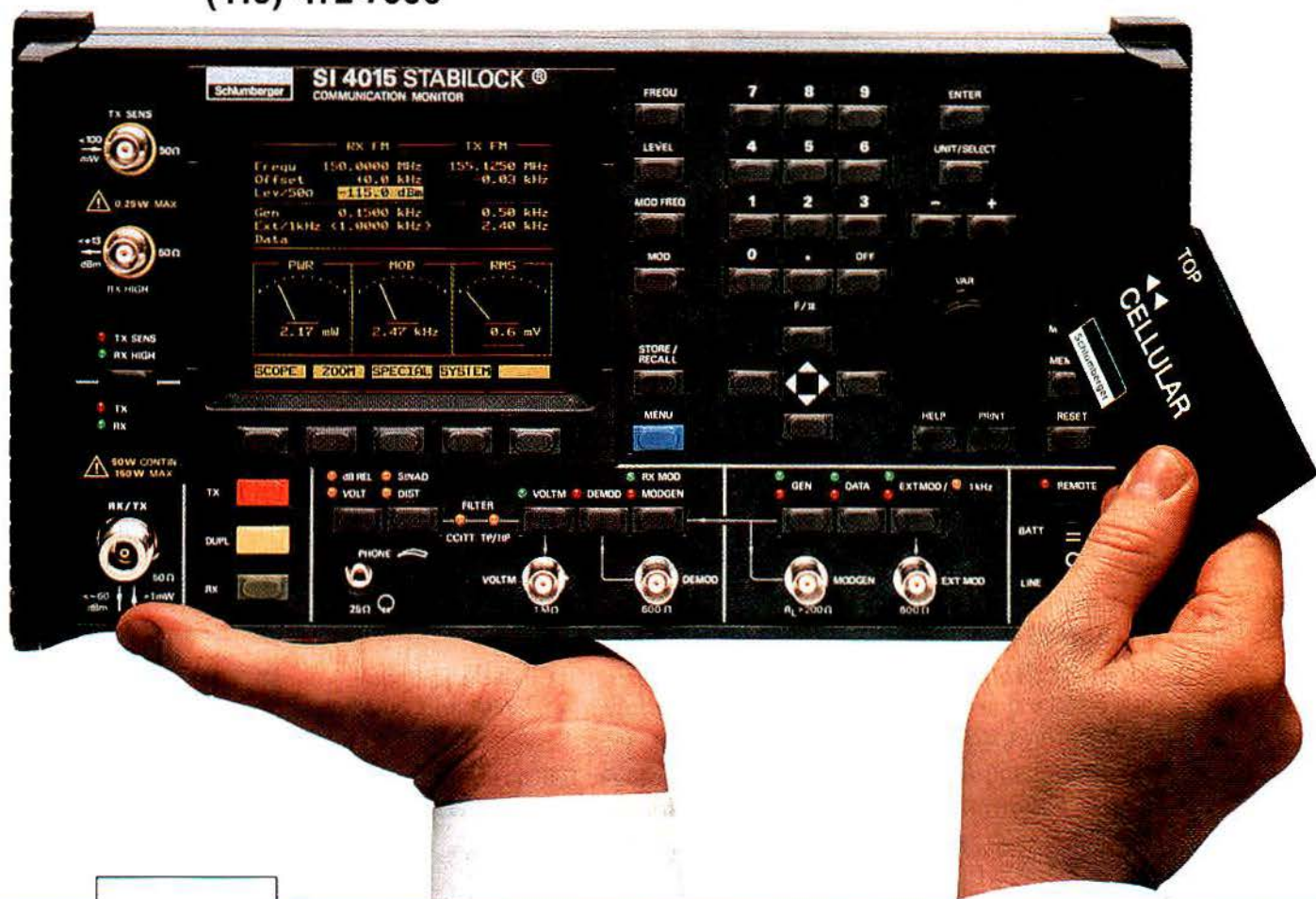
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Circle (53) on Fast Fact Card

Readers' choice

Of all the new products and services in the November 1993 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Mobilfones convert conventional radios into trunking radiotelephones

The RTX 8500 portable mobilfones consist of Maxon UHF or VHF SP-2000 hand-held radios modified by an RTX 7515 mobile control module that converts conventional 10-channel Maxon radios into 16-channel portable trunking radiotelephones. Features include multiple trunking groups for roaming on multiple systems; a private dispatch channel; the ability to place telephone, dispatch or car-to-car calls from any specific channel with simple keypad entries; and complete RTX programming from the keypad without opening the cover.

Circle (501) on Fast Fact Card

Pager features angled top-mount display, eight-message memory

The Bravo Encore! pager from Motorola features an angled, top-mount display that makes reading messages easier and a control-forward design that puts the most-used controls on the front of the pager. The pager has a memory capacity for as many as eight 12-digit nu-

merical messages, time-of-day readout and message time stamping. The Bravo Encore! alerts the user to an incoming message in either the silent vibration mode or by a melodic tone. It is powered by a single AAA battery.

Circle (500) on Fast Fact Card

Product expansion adds mobile with encryption, compact repeater

E.F. Johnson extends its Summit series of products with the Summit DM mobile and repeater. The Summit DM mobile features encryption, a unique Universal Digital and Data Interface, Write-On flash programming capability, programmable option buttons and a user menu function. The mobile offers Multi-Net features and meets all

MIL STD 810 specifications.

The Summit QX repeater fits an entire channel—logic, receiver, exciter, power amp and power supply—into a rack space 8 3/4" high. The repeater is modular for optional feature installation and technology upgrades.

Circle (502) on Fast Fact Card

Chemical grounding rods create low-resistance path to ground

The chemical grounding system (CGS) from Jackson Telecom continuously conditions the soil to provide a low-resistance path from the earth to the unwanted electrical current. The rods provide the lowest resistance to ground regardless of the amount of moisture, type or chemical content of the soil. The

system is available in two configurations. The horizontal system is made for installation in a trench, and the vertical system is made to be placed in a pre-drilled hole. The CGS can be placed under pavement or concrete slabs, or inside a building.

Circle (503) on Fast Fact Card

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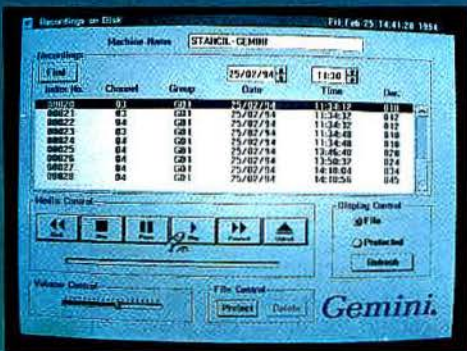


The Dynamic Duo

DAR -

"Digital Archive Recording" stored on a DAT (digital audio tape)!

Gemini will always represent the leading edge in digital voice recording. Any new development in computer technology such as compression, storage formats or even hardware will be added to Gemini's proven Windows operational software to provide unrivaled accuracy, reliability and desktop convenience.



DAR - Gemini provides archival recording linked to DAT (Digital Audio Tape), currently the most cost effective high capacity digital storage format, saving 24 hours of conversation on each recording channel. A mouse driven GUI (Graphic User Interface) allows for simple location of stored conversations and total control of playback. Click on the selected channel,

Circle (55) on Fast Fact Card

DIR -

"Digital Instant Recall" - retrieved in microseconds!

and a list of conversations is displayed. Point and click on a record, and the conversation is instantly played back. The slider shows your exact position in and movement through the recorded conversation.

DIR - In addition, Gemini comes standard with "Instant Recall". All calls are written to a hard disk allowing for instant playback without interrupting recording of incoming calls. Channels are recorded on a FIFO basis (First In First Out). The size of the hard disk governs how many hundreds of hours of conversations can be stored for this instant access. At a convenient time in the process the hard disk writes to the DAT drive for archive but remains available and can be saved on the hard drive indefinitely.

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New products

Site monitor simultaneously checks forward and reflected power modes

The AMV-6A, for RF transmitters and antenna equipment, measures RF power from 1W to 990W in both the forward and reflected modes virtually simultaneously to compare power for VSWR calculations. The unit, from Sinclair Radio Laboratories, may be used as a stand-alone power and VSWR meter without disconnecting coaxial lines.

Circle (300) on Fast Fact Card

GSM radiotelephone test set provides pass/fail and detailed analysis

Tektronix introduces the Rohde & Schwartz CMD 52 Digital Communications Test Set for both pass/fail and detailed analysis of GSM digital mobile radio transceivers. The instrument incorporates an RF signal generator that covers the 935.2MHz to 959.8MHz GSM band, a peak power meter, dc voltmeter, current-averaging dc ammeter and extensive signaling capabilities. The unit features a large high-resolution backlit LCD, softkey



controls and intuitive internal software. Circle (301) on Fast Fact Card

Lightweight hand-held's features include programmable power level

Icom's compact IC-F30LT/F40LT commercial hand-held radio has 96 channels with an eight-digit alphanumeric display. Power settings may be customized by channel for full 5W of high power or programmable low power output. IC-F30LT VHF frequency coverage is from 136MHz to 150MHz and from 146MHz to 174MHz. The IC-F40LT UHF coverage is 400MHz to 430MHz and 430MHz to 470MHz. The radio has a one-piece, aluminum diecast frame for durability with a polycarbonate shell for lightness. Functions may be customized from the front keypad, including repeater or talk-around modes, emergency call and high/low power.



Circle (302) on Fast Fact Card

Folded dipole arrays boasts durable welding, splice overmolds

Maxrad introduces the MFDA series of 450MHz to 470MHz folded dipole arrays. The two-bay or four-bay folded dipole arrays feature 360° welding of the elements to the mast. The phasing harness is internally attached to the dipoles in combination with tough plastic overmolds over low-loss cable splices for increased weather protection. They are field-adjustable for omnidirectional or elliptical coverage. A mounting kit is included.

Circle (303) on Fast Fact Card



Receive only	Freq. Ranges (MHz)	N.F. (dB)	Gain (dB)	Comp. (dBm)	Device Type	Price
P30VD, P35VD, P40VD, P45VD	30-35, 35-40, 40-45, 45-50	<1.3	15	0	DGFET	\$ 44.95
P30VDG, P35VDG, P40VDG, P45VDG	30-35, 35-40, 40-45, 45-50	<0.5	26	+12	GaAsFET	\$109.95
P150VD, P160VD, P170VD	150-160, 160-170, 170-180	<1.5	15	0	DGFET	\$ 44.95
P150VDA, P160VDA, P170VDA	150-160, 160-170, 170-180	<1.1	15	0	DGFET	\$ 56.95
P150VDG, P160VDG, P170VDG	150-160, 160-170, 170-180	<0.5	24	+12	GaAsFET	\$109.95
P450VD, P460VD	450-460, 460-470	<1.8	15	-20	Bipolar	\$ 49.95
P450VDA, P460VDA	450-460, 460-470	<1.2	16	-20	Bipolar	\$ 74.95
P450VDG, P460VDG	450-460, 460-470	<0.5	16	+12	GaAsFET	\$109.95
P800VDG, P830VDG, P860VDG	800-830, 830-860, 860-890	<0.6	19	+12	GaAsFET	\$119.95
Inline (rf switched)						
SP30VD, SP35VD, SP40VD, SP45VD	30-35, 35-40, 40-45, 45-50	<1.4	15	0	DGFET	\$ 74.95
SP30VDG, SP35VDG, SP40VDG, SP45VDG	30-35, 35-40, 40-45, 45-50	<0.55	26	+12	GaAsFET	\$139.95
SP150VD, SP160VD, SP170VD	150-160, 160-170, 170-180	<1.6	15	0	DGFET	\$ 74.95
SP150VDA, SP160VDA, SP170VDA	150-160, 160-170, 170-180	<1.2	15	0	DGFET	\$ 86.95
SP150VDG, SP160VDG, SP170VDG	150-160, 160-170, 170-180	<0.55	24	+12	GaAsFET	\$139.95
SP450VD, SP460VD	450-460, 460-470	<1.9	15	-20	Bipolar	\$ 79.95
SP450VDA, SP460VDA	450-460, 460-470	<1.3	16	-20	Bipolar	\$104.95
SP450VDG, SP460VDG	450-460, 460-470	<0.55	16	+12	GaAsFET	\$139.95

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Circle (58) on Fast Fact Card

New products

Portable radio delivers full duplex interconnect and trunking capability

Ericsson GE Mobile Communications introduces the Allegra, a lightweight portable radio featuring full-duplex telephone interconnect and the advantages of trunking. The 11.7-ounce Allegra has a two-



line, eight-character alphanumeric display, 50-number storage, a 12-button DTMF pad, last-number redial and call length timer. Two models are available, one with telephone interconnect only and a second that adds full dispatch capability. That capability enables users to access advanced trunking functions of Ericsson GE's EDACS, such as emergency signaling, group call and virtual nonstop trunking.

Circle (304) on Fast Fact Card

Hardware-independent modems permit access to centralized databases

The MPAD-96V and MPAD-96U RF modems from Metropex Mobile Data are completely self-contained high-speed RS-232 devices. They are hardware-independent and permit any laptop, notebook or palm-top computer access to centralized databases. Coupled with Metropex's long-range radio network, the units allow the

user in the field to communicate with the hardwired world. The units are available in 150MHz, 460MHz, 800MHz and 900MHz versions. Output power ranges from 1W to 15W for the self-contained unit. Two-piece units provide for as much as 120W of output power.

Circle (305) on Fast Fact Card

Repeater extends 900MHz paging service coverage to fringe areas

PageThru is a synthesized 900MHz paging repeater from the Grayson Electronics division of Allen Telecom Group. The repeater extends service areas previously on the fringe of service coverage. The 1.75"H x 17"W x 12"D paging repeater is user-programmable to any designated frequency between 929MHz and 932MHz and is PC-programmable. PageThru's repeating functions are transparent across all paging formats for immediate integration into any 900MHz paging network. It of-



fers customized propagation patterns, field-adjustable frequency tuning and protection from adjacent channel transmissions.

Circle (306) on Fast Fact Card

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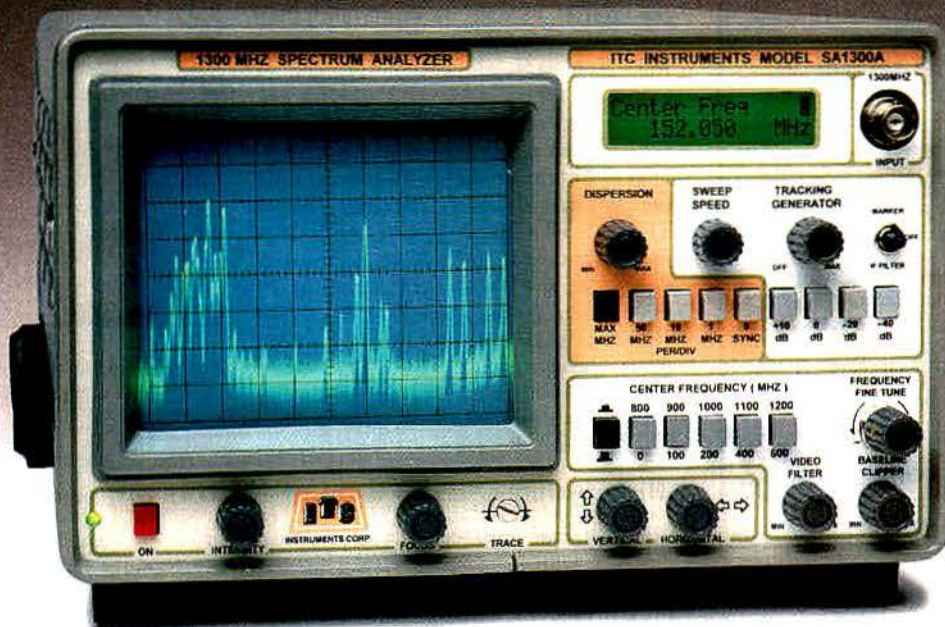
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Circle (59) on Fast Fact Card

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ITC SA Series exclusive Dispersion Zoom lets you zoom in on **any Center Frequency** signal, from any one of five calibrated Dispersion positions. Preset at >140 MHz, 50MHz, 10MHz 1MHz and zero MHz per division. The SA1300A displays greater than 1300 MHz on the screen at one time yet allows instant zoom to any Dispersion Scan Width as low as zero MHz per div. Allowing for total control over all **Dispersion Scan Widths** settings.

80 dB ON SCREEN

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ITC Spectrum Analyzers are the best performance to price ratio Analyzers on the market today. No other low cost Analyzer comes close to the Superior performance and quality of an ITC Analyzer. **Total flexibility and ease of operation.** SA1300A gives you full control over the Resolution Band Width and Freq. Span widths. Plus Vertical Position, Baseline Clipper, Sweep Speed, Video Filter, 4 Input Attenuator settings, 10 Frequency Select settings.

MODEL SA1800B 1800 MHz

Covers 1-1300 MHz and 850-1850 MHz in one sweep. Ideal for Satellite service. The **SA1800B** has the same general specifications as the model SA1300A.

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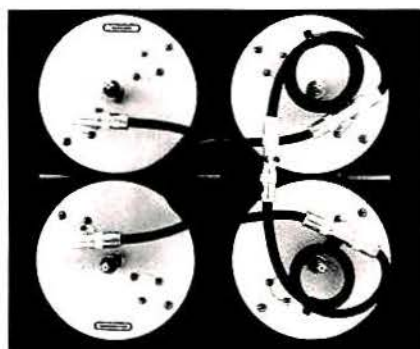
P.O. Box 9446 (316) 265-2050
Wichita, KS. 67277 Fax: (316) 265-2255

Circle (61) on Fast Fact Card

New products

Duplexers allow simultaneous Tx/Rx operations into common antenna

Three bandpass-bandreject duplexers for 66MHz-88MHz operation with 300/600kHz minimum frequency spacing, from Telewave, allow simultaneous operation of a transmitter and a receiver into a common antenna. They are designed for frequency-congested areas requiring protection from surrounding transmitters and maximum sideband filtering. Model TPRD-0754, with two pass/reject cavities in the transmitter and receiver sections, is designed for frequency spacing of 600kHz or more. Model TPRD-0756, with three pass/reject cavities, is designed for frequency spacing of 300kHz or more. Model TPRD-0784, with two pass/reject cavities, is designed for frequency spac-



ing of 300kHz or more.

Circle (307) on Fast Fact Card

High-resolution terrain database increases coverage prediction

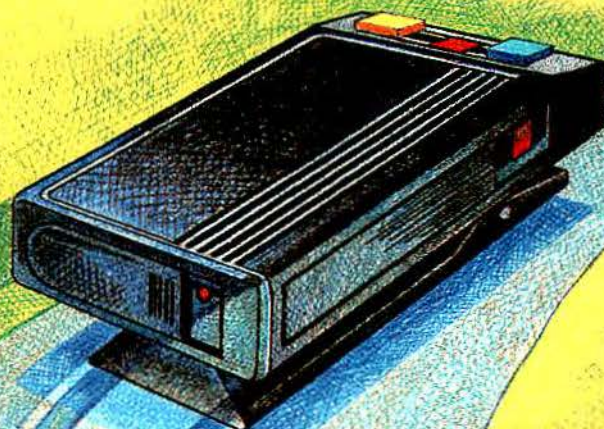
SoftWright introduces a topographical database with increased accuracy for use with its Terrain Analysis Package (TAP) to make radio coverage prediction more accurate. The database, based on the 7½" quadrangles, uses a grid interval of 30 meters. This provides an increase in grid

density of about nine times the data within a given area. In TAP, the new 30-meter resolution data can be selectively overlaid onto the path in areas where the maximum elevation accuracy is desired.

Circle (308) on Fast Fact Card

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Circle (62) on Fast Fact Card

Rugged conventional mobile features priority scan and knob controls

The Avenger GX mobile radio from E.F. Johnson is a tough 99-channel conventional radio available in VHF and UHF models at two power ranges. The mobile features a die-cast aluminum chassis and covers for harsh environments. It meets MIL STD 810 specifications for shock, vibration and temperature extremes. The Avenger GX has a backlit numeric LCD, full keypad, priority scan, multiple scanning methods, optional emergency operation mode and easy-to-use knob controls.



Circle (309) on Fast Fact Card

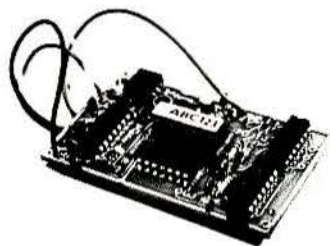
Reflectometer locates and identifies metallic cable faults



The model 1205T dual line time domain reflectometer from Riser-Bond Instruments, designed specifically for outside

plant use, locates and identifies faults in all types of metallic cables. The Autosearch mode places a waveform from the beginning of the cable up to the first fault. Waveform information and instrument settings are displayed on a large LCD with EL backlighting, variable contrast settings and automatic or manual filtering. Four to 16 waveforms can be stored on-board. Unlimited storage of waveforms to a PC is available through a RS-232 serial output.

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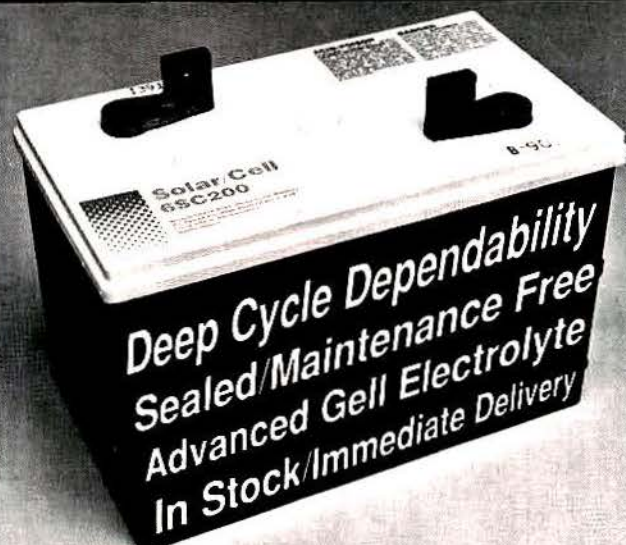


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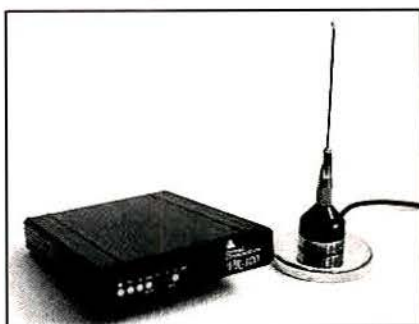
Order Hotline 800-344-2003

Circle (65) on Fast Fact Card

New products

Vehicular repeater extends range for UHF hand-helds

The VR-100 low-power vehicular repeater from Pyramid Communications provides extended range to UHF hand-helds by crossband repeat operation with an existing mobile. The VR-100 is Motorola PAC/



RT-compatible and provides features for "first man out," priority sampling, multi-vehicle operation and local mic repeat. Jumper-selectable options include conventional/trunking applications, lock tone frequency, priority sample rate, COR polarity, remote enable polarity and flat or 6dB/octave audio response. The VR-100 is 5.25"W x 6"L x 1.1"H and weighs 18oz.

Circle (311) on Fast Fact Card

Antenna line offers range of four styles for hand-helds

Advanced Fox Cellular introduces a four-style line of antennas for all hand-held portable phones. The styles include: high-quality, gold-plated and black-alloy tilt and telescoping antennas; gold-plated, 1" button antennas; 1", 3", and 6" rubber duck antennas; and replacement/retractable antennas with installation tool.

Circle (312) on Fast Fact Card

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Circle (66) on Fast Fact Card

Laptop design addresses harsh environment needs

U.S. Microtel's RMC-4000 486 laptop computer meets MIL STD 461/462 standards for EMI and RFI, and MIL STD 810E standards for shock, vibration, humidity and other environmental conditions. The computer is designed for GPS use with an optional PCMCIA card or embedded GPS device.



Circle (313) on Fast Fact Card

Hand-held field strength meter handles broad range

The R-501P field strength meter from Z-Technology is a hand-held unit providing highly accurate off-air measurement of RF power levels for signals within a broad frequency range as high as 1,000MHz. It allows the user to measure power levels as large as 0.3V or as small as 0.32µV. Internal data logging and storage are accessed directly from the front panel. The unit includes a serial data port.

Circle (314) on Fast Fact Card

Power to the System!

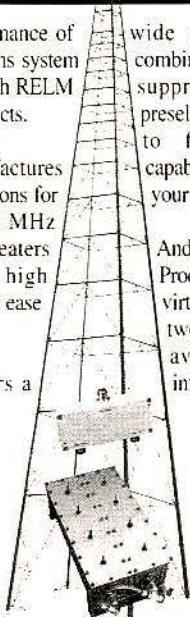
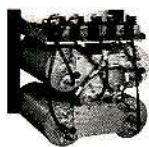
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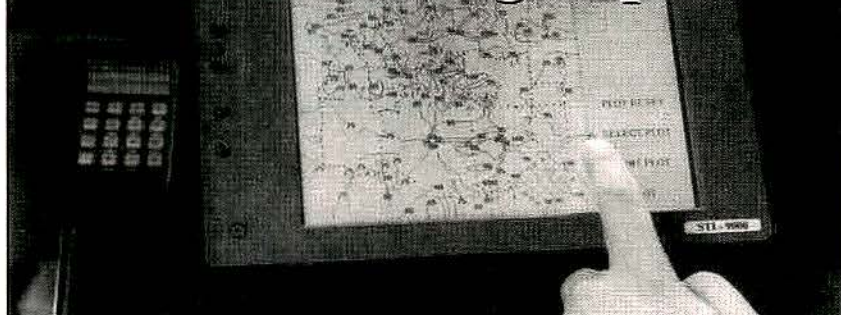
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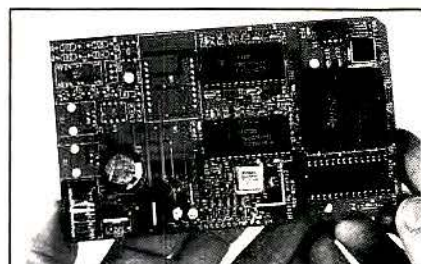
Circle (69) on Fast Fact Card

New products

Digital hybrid eliminates feedback and loud interconnect sidetones

IDA introduces a digital hybrid for full duplex interconnects. Model DHyB uses DSP technology and is available in an upgrade kit for use with IDA's model RIC2000 trunking interconnect as well as Uniden ARX 780's and E.F. Johnson LTR interconnects. The DHyB eliminates feedback and loud sidetones when using hands-free full duplex interconnects.

Circle (315) on Fast Fact Card



Compact 5W radio features user-selectable scan, multiple CTCSS tones

MicroTalk is a 5W, 10-channel synthesized two-way radio featuring user-selectable scan to lock out or avoid busy channels. The compact (4 1/4" x 2 1/16") radio from Advanced Videotech



has multiple CTCSS tones and an automatic backlight turn-off to reduce power consumption. MicroTalk is available in VHF 148MHz-174MHz and UHF 450MHz-470MHz frequencies. All function keys are located on the front panel. The radio comes with belt clip, 600mAh battery, 110Vac wall charger, rubber duck antenna and wrist strap.

Circle (316) on Fast Fact Card



EMITTER LOCATION

Direction Finding System Tracks Down

- Stuck Microphones
- Cable TV Leaks
- Jammed Repeaters & Cell Sites

Models available with computer interface, synthesized speech, for fixed or mobile use, covering 50 MHz to 1 GHz. Call or fax for details



Circle (70) on Fast Fact Card

Catalog introduces low-voltage installation and maintenance products

"The Jensen Connection," a 52-page catalog, provides answers to questions about the installation and maintenance of low-voltage systems and equipment. The catalog from **Jensen Tools** describes tools, test instruments, cable, connectors and installation hardware for CATV, security systems, PC LANs and other high-tech equipment. Products listed include network outlets, patch panels, wiring blocks, equipment racks, converters, boosters, adapters, gender changers, breakout boxes and cable testers, as well as reference books such as the *Network Interface Guide*, *Technician's Guide to Fiber Optics* and the *Novell Companion*.

Circle (450) on Fast Fact Card

Catalog describes 1.12GHz-40GHz microwave waveguide, coaxial components

A 68-page catalog describes microwave waveguide and coaxial components for use in the 1.12GHz-40GHz range. The catalog from **Omega Laboratories** features a wide range of standard microwave components that can be combined and integrated into complete systems. Included are adapters, attenuators, bends, directional couplers, detector mounts, flanges, horns, pressure adapters and windows, tuners, twists and terminations. The catalog provides product descriptions, photographs and technical data for components that range from ordinary bench hardware to sophisticated instruments suitable for use in a standards laboratory.

Circle (451) on Fast Fact Card



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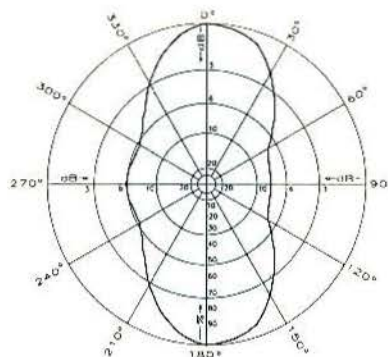
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Circle (72) on Fast Fact Card

Jim Brennan, general manager of Paging Dimensions, Orange, CA, advances to executive vice president.

Klein S. Gilhousen, senior vice president of systems and technology for Qualcomm, San Diego, has been elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE).

Changes at E.F. Johnson, Burnsville, MN:

Charles Richard Abbruscato leaves Racal-Datacom, Sunrise, FL, as product vice president to join E.F. Johnson as engineering and technology vice president.

Stephen D. Ruskin departs Ericsson GE, Lynchburg, VA, as territory sales manager to become director of North American sales for E.F. Johnson.

Mike Wallace exits Scientific Atlanta as manufacturing engineering manager for electronic products to become vice president of operations at Transcrypt International, Lincoln, NE.

Brian F. Fontes, senior advisor to FCC Commissioner James Quello, receives the Eugene C. Bowler award from the Eugene C. Bowler Foundation.

Robert W. Wark leaves CrimTec Systems, Livonia, MI, as director of operations to become Midwest regional sales manager for ElectroCom Communication Systems, Santa Fe Springs, CA, in the company's White Lake, MI, office.



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Cleveland W.T. Rd	Mt. Echo	Calhoun Hall	Greenhills
Sweetwine	Miami W	Comm Center	Loveland W.T.
Anderson Twp. Rd	Greenhills		Mt St Joseph
Greenhills Vote	Cleves		Sweetwine
Engineers	Fernald		Miami W
Milford	Prov. Hosp.		Glendale W.T.
Marlinton	Mt St Joseph		Marlinton
Calhoun Hall	Engineers		Cheviot
	Miamitown		Cleves
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			Mt. Echo
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Remote Comparator Display

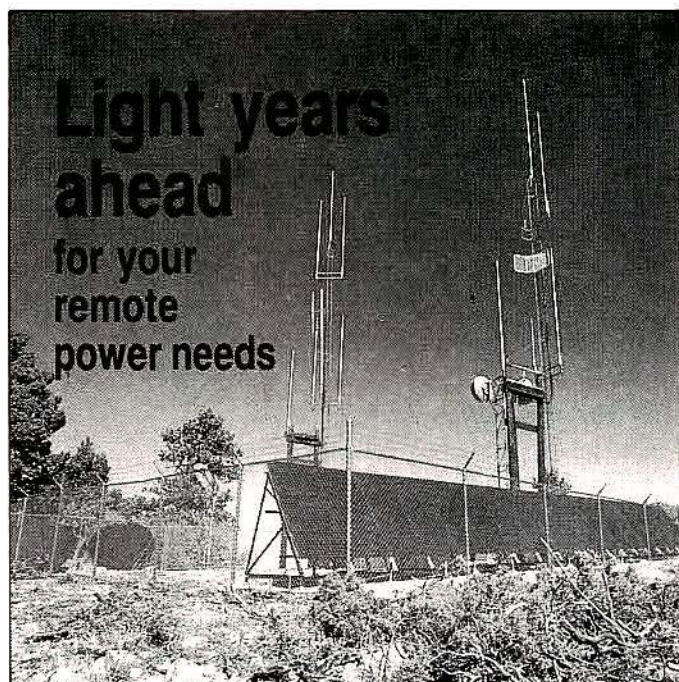
The Smartswitch II™ Remote Comparator Display monitors and controls voting receiver systems on a personal computer or console. It can be used locally or remotely with leased-line or dial-up modems.

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Circle (73) on Fast Fact Card



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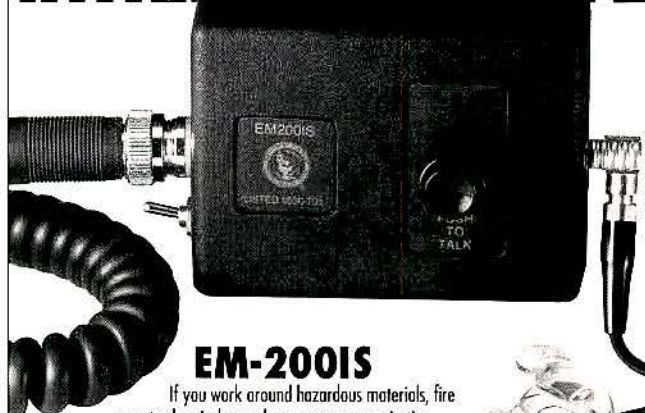
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Circle (75) on Fast Fact Card

L etters from readers

Technician licensing:

I enjoyed your editorial comment on the possibility of the FCC resurrecting technician licensing. I agree wholeheartedly with the statements about those areas that would bring back the pride and professionalism involved with holding an FCC license.

Even though I am an engineer (BSEE) at this time, I still look back with pride on my technician days. The highlight of my technical career was when I received my FCC First Class Radiotelephone Operator license. I still remember how the other people I worked with responded to that achievement.

After I had gotten my license, I posted it with great pride and vowed never to do anything to jeopardize my standing with the FCC. But when the FCC dissolved the licensing and issued me an almost meaningless General Radiotelephone Operator License, it was like being in the military and having them take my stripes away. Same pay, but no prestige!

Now I am going through the testing process for my professional engineer certification. I'm sure that when the process is complete and I am a registered professional engineer, I will be as proud as punch! This achievement, however, will

never diminish the pride I had when I was a First Class FCC license-holder.

John F. Verhyen
Chief, Engineering and Planning
Wisconsin Department
of Transportation
Division of State Patrol
Madison, WI

Fast Fact Card comments:

The two toughest problems facing me on the job are:

- Caller ID.
- Billing and collection.

Frank Mead
Caretaker Security Service
Kailua Kona, HI

The two toughest problems facing me on the job are:

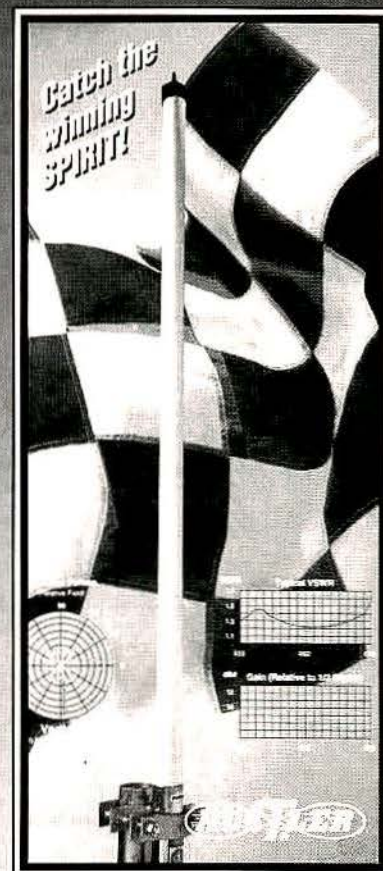
- Getting repair parts through the federal supply system.
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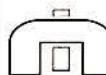
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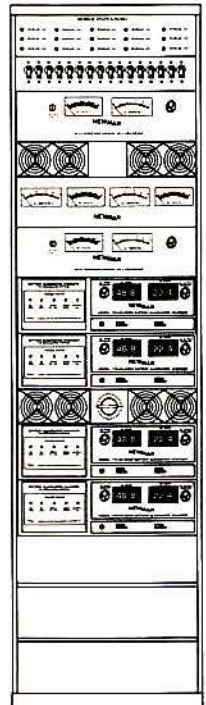
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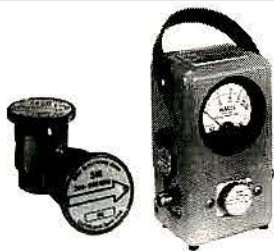
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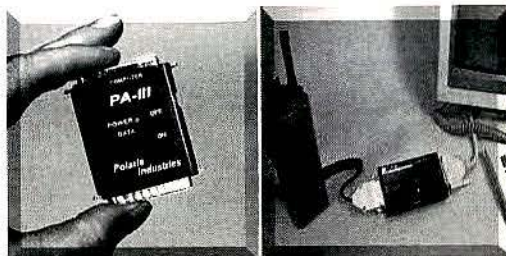
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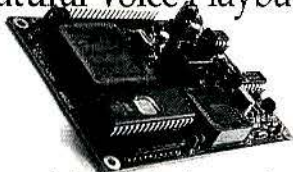
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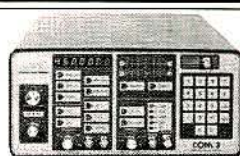


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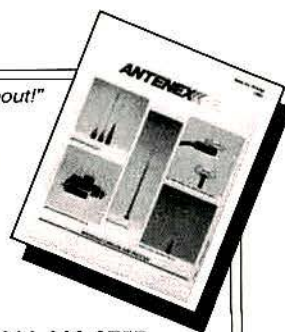
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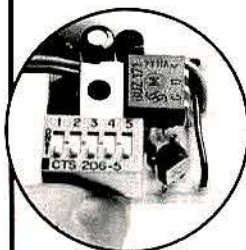
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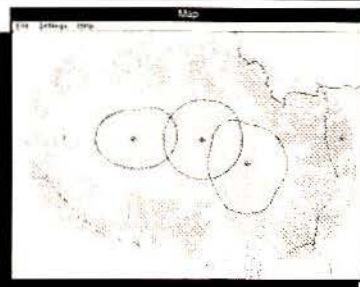
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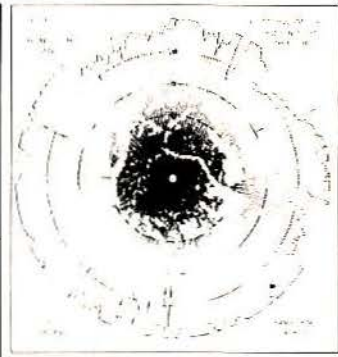
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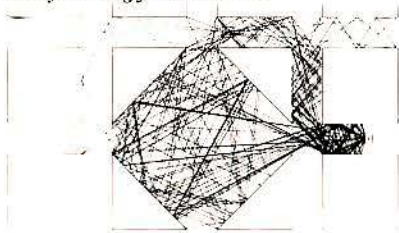
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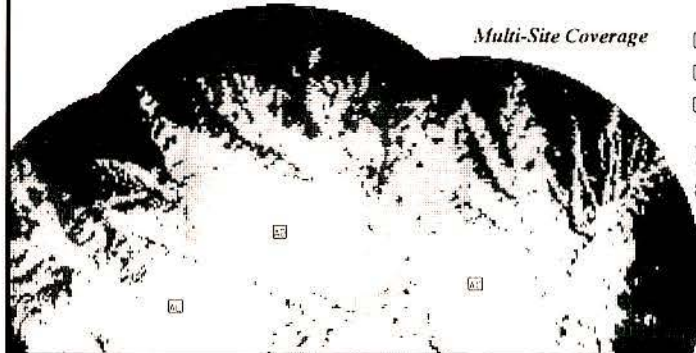
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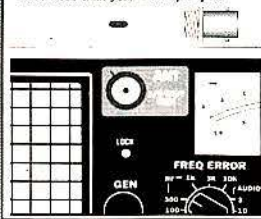
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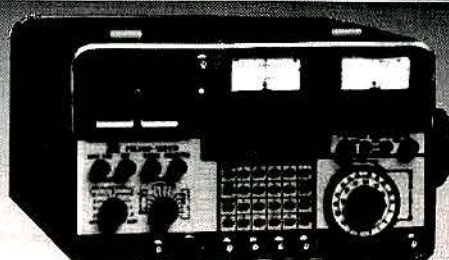
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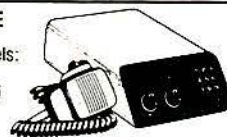
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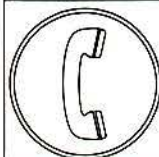
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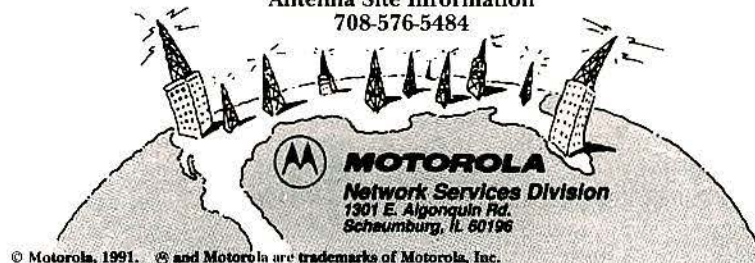
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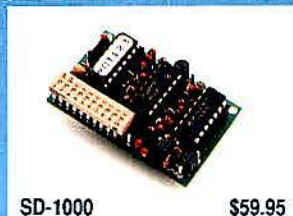
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